Microsoft Lync Devices Video Capture Specification

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1.0 Revision History

Revision	Date	Description	Author
A	July 2009	First release	Ross Cutler
B	November 2009	Added pixel aspect ratio, focus requirements. Made directivity a Premium requirement. Clarified oversharpening and geometric distortion is absolute. Clarified framerates. Added colorspace details. Updated dynamic range test. Added alternate to light sphere. Added requirement that MTF30<1. Renamed P420 to M420. Added check for color range. Added frame rate tests for 100 and 300 lux. Temporal SNR is measured in 300 lux.	Ross Cutler
C	April 2010	Added M420, NOISE_REDUCTION, FACE_DETECTION GUIDs. Removed HFOV requirement and added relaxed VFOV standard requirement. Relaxed DOF max distance from 3m to 1.5m. Relaxed time to capture first image from 300ms to 500ms; changed measurement method. Audio specification refers to Microsoft Lync Devices Audio Specification. Dynamic range uses Rev A method (too many cameras don't have manual exposure; method is accurate enough). Added color ratios for relative illumination. Updated Auto exposure / gain test. Uses Day instead of U30 for most tests (more uniform in light box). Changed AEC/AGC test method. Changed doc title. Added A/V synchronization. Made spatial SNR lighting specific with two lighting conditions. Added overhead lighting test. Added test setup sections; added Imatest figures. Added max for relative illumination, color ratio. Updated usage light. Relaxed VGA latency to 70ms. Made manual focus default 0.5m. Made time to change resolution P2. Added formula for AEC/AGC to clarify. Clarified that all audio/video tests need to be run with both Windows and any provided drivers. Added room light measurement section with ANSI and OSHA based room light values. 50/60 Hz test uses temporal SNR for more robustness. Now uses total PC CPU time for CPU usage test.	Ross Cutler
D	October 2010	Uses new lighting to achieve greater uniformity and better test accuracy. Uses 3500 K instead of U30 because 3500 K is much more common. Uses ΔC for color uniformity (based off CPIQ test) to improve test accuracy. Reduces number of light levels to improve testability. Uses ΔC00 for color accuracy to improve test accuracy. MTF uses large squares and lower contrast target to improve test accuracy. Temporal noise uses Imatest. New ColorRange filter supports MJPEG color range. Added Camera position API to enable improved eye gaze, support image orientation. Improved results workbook to improve testability. Added camera lens protection guidelines. Added lens cleaning guidelines. Updated AV sync spec to align with ITU-R BT.1359-1. Added related standards to relevant tests. Temporal and spatial SNR use the 0.7 density patch, which is closer to skin reflectance than SNR_BW patches; the criteria have been adjusted.	Ross Cutler

E	April 2011	Added Basic criteria and formula for Basic, Standard, and Premium certification. Added LyncVidCap test tool to allow easy image capture, frame rate and jitter measurement, latency and AV sync. Added definitions section. Added examples of good and bad images for most metrics. Tightened upper limit to MTF30. Uses 50/200 lux lighting for all measurements except overhead lighting. Added conference room camera criteria. Added home lighting scenario criteria. Added 1920x1080, 848x480 resolutions, removed 960x544 and 800x448 resolutions.	Ross Cutler
F	October 2011	Added lower resolutions must have better SNR test. Added veiling glare test and removed overhead lighting test. Added 540p resolution and updated P1 resolutions for 16:9 webcams to align with W15. Updated DOF test target focal distance. Added color saturation test. Changed autofocus MTF requirements from 10 to 15%. Added ACPI requirement for notebook and embedded camera location. Updated (relaxed) AV sync requirement.	Ross Cutler

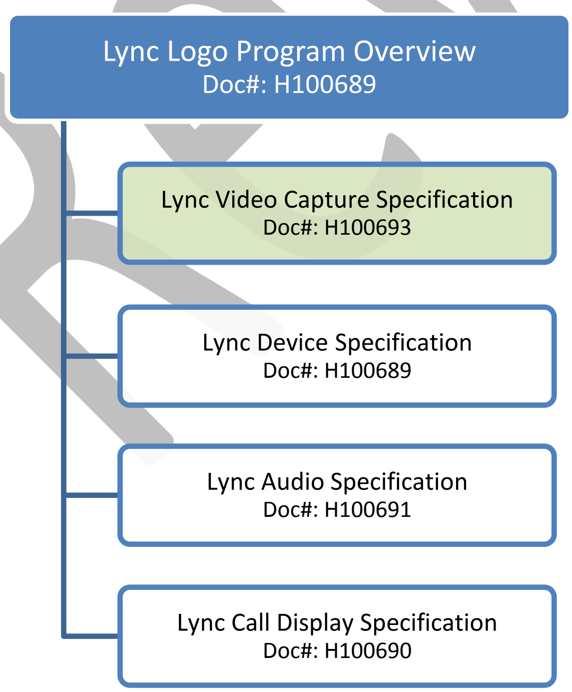
2.0 Overview

The technical requirements listed in this document, the *Microsoft Lync Devices Video Specification Version*, have been derived solely for the purpose of maximizing interoperability and optimizing the functional and quality experience of devices used with Microsoft Lync Server 2010 platform and certified under the *Optimized for Microsoft Lync Logo Program*. Any use of this technical specification for platforms other than the *Microsoft Lync Server 2010* platform is not authorized.

Partners, who license, develop market and/or sell Microsoft Lync devices that are qualified by Microsoft are required to adhere to the specifications outlined in this document. Partners seeking changes, modifications and/or additions to this specification will be required to receive written approval from Microsoft before certification of the device. Microsoft reserves the right to update the contents of this technical specification at any time without prior notice. Purposes of such updates include the capture of new capabilities in Microsoft Lync platforms, new device categories, as well as performance improvements in the hardware used in peripheral devices.

3.0 Test Specifications

The family of Microsoft Lync documents supporting the Lync logo program is shown here and contains detailed requirements that candidate devices, being submitted to the Lync logo program, must meet. The technical requirements listed herein have been derived solely for the purpose of maximizing interoperability and optimizing the functional and quality experience of devices used with the Microsoft Lync platform. The test specifications are split into the four categories shown here:



This *LYNC Video Capture Specification* document details the image capture requirements for devices submitted for qualification to the Lync logo program. This document includes the following:

- A description of driver and CPU usage requirements for webcams and Lync PCs
- Required (P1) resolutions and color spaces for webcams and Lync PCs
- Image quality and functional requirements and test methods for webcams and Lync PCs

3.1 Additional References

This document references the following industry standards as well:

Document Name	Version	Hyperlink
Universal Serial Bus Specification	2.0	http://www.usb.org/developers/docs

Technical support and related information can be obtained from the following Microsoft websites:

Microsoft Developer Network (MSDN®), including newsgroups and library of technical information	http://msdn.microsoft.com/
Microsoft Lync / Office Communications Server Community	http://technet.microsoft.com/en-us/office/ocs/cc793962.aspx
Microsoft Knowledge Base	http://support.microsoft.com/

3.2 Contacting Microsoft

For any questions regarding the requirements detailed in the specification, please contact the Microsoft Lync Partner Team by sending an email message to lynclogo@microsoft.com.

3.3 Terms Used in This Document

This section describes standard terms and conventions used throughout the Microsoft Lync Device Specification.

3.3.1 Non-technical terms

Device Qualification	Refers to the process of formally submitting a device for qualification under the *Optimized for Microsoft Lync Logo Program*.
DUT	Device Under Test
Must	Refers to whether a device is required to implement the requirements outlined supporting a scenario for a particular device category.
ML	Microsoft Lync, an acronym for the implementation by Microsoft of unified communications.
Lync PC	Official category name for PC with integrated loudspeakers and microphone(s) which is optimized for Microsoft Lync. This includes laptops, netbooks, PCs integrated in monitors, desktop PCs bundled with audio devices, etc.
LyncVidCap	Video capture test tool currently under development by Microsoft. LyncVidCap leverages AmCap. It is expected to give similar results to previously reported test methods in Rev D spec, but with lower chance of error and require less time to test. The tool is scheduled to release in late 2011.
Optional	Refers to whether a device can optionally implement the requirements outlined that support a scenario for a particular device category.
ROI	Region of Interest

UC	Unified Communications, a set of products and services integrating non real-time and real-time communication services into a consistent user interface and experience.
UCW12	Abbreviation for "Wave 12", Microsoft Office Communications Server 2007 platform launched in 2007.
W13	Abbreviation for "Wave 13", Microsoft Office Communications Server 2007 R2 platform launched in 2009.
W14	Abbreviation for "Wave 14" or codename for Lync 2010.
W15	Abbreviation for "Wave 15" or codename for Lync 2012, currently targeted for release in 2012.
Webcam	A webcam is a video camera which feeds its images in real time to a computer or computer network, often via USB or MIPI. Webcams can be tethered (e.g., external USB) or integrated into notebooks, tablets, or display monitors.

Table 1: Non-technical terms used in this specification

3.3.2 Technical terms

Color accuracy	The measurement of the deviation of colors captured by a camera and the expected colors using a test chart like the ColorChecker.
Color uniformity	The measurement of the variation of color throughout an image (not just the center compared to the edges).
Color space	A color space is a mathematical model describing the way colors can be represented as tuples of numbers, typically as three or four values or color components. The standard PC color space for displays is sRGB, while webcams generally use YUV color spaces for capture.
Depth of field	Depth of field is the distance between the nearest and farthest objects in a scene that appear acceptably sharp in an image.
Dynamic range	Dynamic range is the ratio between the largest and smallest possible values of a changeable quantity. For imaging it is measured by how many F-stops can be imaged in one scene, which can be done with a step chart like the ST-52.
Field of view	The field of view is the angular extent of the observable world that is seen at any given moment from a camera.
Focus	An image, or image point or region, is in focus if light from object points is converged almost as much as possible in the image, and out of focus if light is not well converged. The border between these is sometimes defined using a circle of confusion criterion.
Gamma	Gamma correction is a nonlinear operation used to code and decode luminance or tristimulus values in video or still image system.
Geometric distortion	Geometric distortion is a deviation from rectilinear projection, a projection in which straight lines in a scene remain straight in an image.
Jitter	Jitter is the measure of time deviation from an expected periodic event. For example, a constant frame rate camera should ideally have a zero jitter, though in practice it is usually a few milliseconds.
Latency	Latency is a measure of time delay experienced in a system. For video conferencing the most important latency measurement is end-to-end latency, which is the time from photons in to a camera to photons out of a display.
MTF	Modulation Transfer Function is the magnitude of the Optical Transfer Function. MTF30 is the cycles/pixel where the MTF=30%, generally considered to be the lowest acceptable MTF for imaging.

Oversharpening	Oversharpening or undersharpening is an Imatest measurement that characterizes the degree that the image is sharpened relative to a standard sharpening model. It if is negative, sharpening is applied to the original response; if it is positive, de-sharpening is applied.
Relative illumination	Relative illumination, or vignetting, is a measure of the image brightness in the center compared to the corners.
RMS edge roughness	RMS edge roughness is an Imatest measurement of how rough an edge is. An edge can be rough due to demosaicing, image scaling, and spatial denoising.
SNR	Signal to Noise Ratio is the ratio of the signal power to the noise power corrupting the signal. The SNR can be measured spatially using a single image or temporally using more than one image.

Table 2: Technical terms used in this specification

4.0 Microsoft Lync Device Video Requirements

This document provides performance requirements for Lync certified USB webcams, both external and integrated webcams (notebooks, tablets and monitors).

There are three levels of camera performance defined by this specification:

- Basic[1]: Gives the minimum bar for webcam performance for use with Lync.
- Standard: Provides better webcam performance than Basic. Standard devices must meet all P1 Basic requirements plus 90% of the P1 Standard requirements.
- Premium: Provides the best webcam performance. Premium devices must meet all P1 Standard requirements plus 90% of the P1 Premium requirements.

Within each level a webcam can be Standard Definition (SD) and High Definition (HD).

4.1 Driver

4.1.1 P1: Support USB Video Class (UVC) Driver

4.1.1.1 Purpose

Lync webcams should be fully functional with default Windows drivers. Note all tests in this specification need to be run with the default Windows drivers as well as the OEM drivers.

4.1.1.2 Requirements

The webcam must support the UVC standard 1.0 or later versions and work with standard Windows XP SP2 or later versions, Windows Vista, and Windows 7 UVC drivers.

4.1.1.3 Test procedure

1. Run Device Manager and check if the webcam is using the Windows UVC driver usbvideo.sys and the provider is Microsoft. If the driver is not the Windows UVC driver, roll back the driver to the Windows UVC driver (see Figure 2).

[1] The Basic level applies for PCs as part of the basic PC category (currently a pilot program). PC makers should contact Microsoft for additional details.

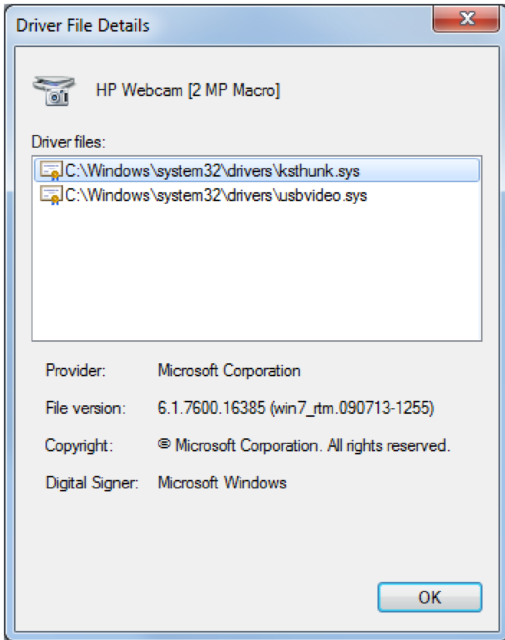


Figure 1: Example of webcam using Windows UVC driver

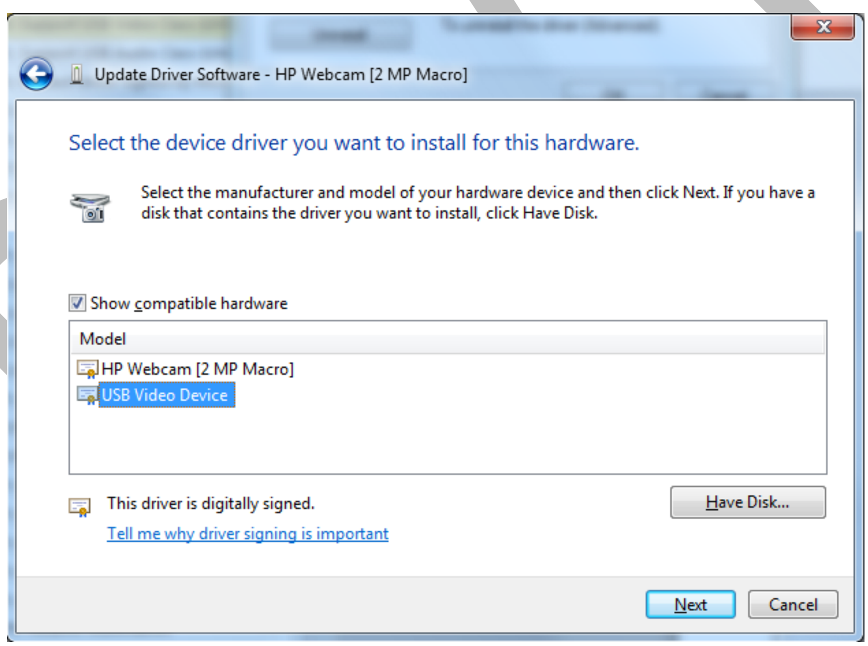


Figure 2: Rolling back to the Windows UVC driver, "USB Video Device"

4.1.2 P1: Support USB Audio Class (UAC) Driver

4.1.2.1 Purpose

Lync webcams should be fully functional with default Windows drivers.

4.1.2.2 Requirements

The webcam must support the UAC standard 1.0 and later and work with standard Windows XP SP2 or later versions, Windows Vista, and Windows 7 UAC drivers.

4.1.2.3 Test procedure

1. Run Device Manager and check if the webcam is using the Windows UAC driver usbaudio.sys and the provider is Microsoft. If the driver is not the Windows UAC driver, roll back the driver to the Windows UAC driver.

4.1.3 P1: Product driver signed by Microsoft (WHQL)

4.1.3.1 Purpose

Ensures basic level of quality for OEM provided drivers.

4.1.3.2 Requirements

The drivers supplied with the webcam must be certified by Microsoft.

4.1.3.3 Test procedure

1. Validate that driver is signed by Microsoft. Open Device Manager / Properties / Driver / Driver Details, and then check whether Microsoft signed the driver. See Figure 3 for an example of a signed driver.

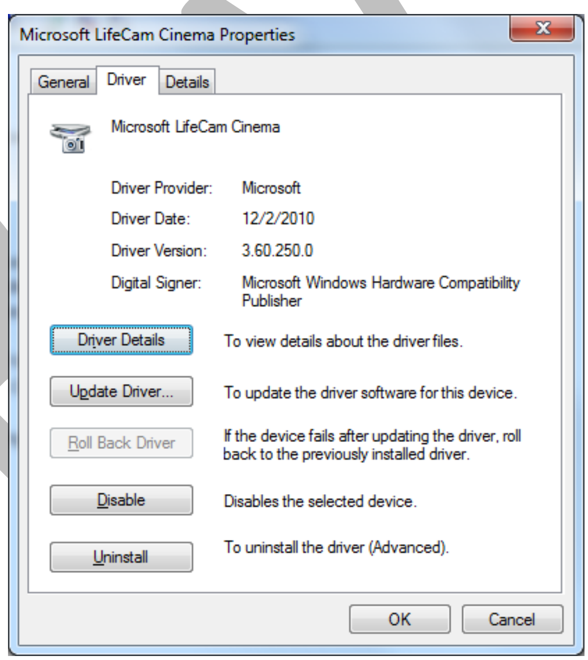


Figure 3: Example of a signed driver.

4.1.4 P2: Method to control video processing in driver/camera

4.1.4.1 Purpose

While temporal and spatial noise reduction can improve image preview, it does not always improve end-to-end video performance since the video codec is a low-pass filter. Face detection may need to be disabled to save CPU usage, or if there are sufficient CPU cycles the face detection can be used to improve video codec performance.

4.1.4.2 Requirements

The requirements are given in Table 3:

Video enhancement	Requirement
Noise reduction	Supports API in Appendix 5.3
Face detection	Supports API in Appendix 5.2 Face detection accuracy MOS ≥3

Table 3: Video processing control

The face detector MOS test is a scenario-based test that provides a Mean Opinion Score on the face detector's accuracy. The test is a check that the face detector works well enough to use for region of interest (ROI) encoding. The MOS score range is as follows: 1= unacceptable performance, 3=acceptable performance and 5=excellent performance.

4.1.4.3 Test procedure

1. Run TestFaceDetectionInterface.exe to test the face detecting interface.
2. Run TestNoiseReductionInterface.exe to test the noise reduction interface.

4.1.5 P1: CPU usage

4.1.5.1 Purpose

Makes sure the webcam driver (not standard UVC/UAC drivers), which includes any video processing, doesn't have excessive CPU usage. Only the CPU usage of OEM drivers are measured, not the Windows in-box UVC/UAC drivers.

4.1.5.2 Requirements

The CPU usage requirements are given in Table 4.

Resolution	CPU usage
CIF 15 FPS, VGA 30 FPS	<10% on 1.8 GHz dual core
720p 30 FPS	<20% on 2 GHz quad core
1080p 30 FPS	<20% on 2 GHz quad core

Table 4: CPU usage

4.1.5.3 Test setup

Lighting	300 +/- 30 lux room (see Section 4.5.2)
Test charts	Not applicable
DUT position	Mounted normally, facing user
DUT settings	Default

Table 5: CPU usage test setup

4.1.5.4 Test procedure

1. For each resolution and max frame rate in Table 4:

a. Run GraphEdit[2] and preview the captured video (see Figure 4).

b. Use Task Manager to measure the average PC CPU usage (see Figure 5). Compare with Table 4 requirements.

Notes:

- A quad core PC can be configured to use only two cores. For example, in Windows 7 use the "System Configuration" tool to set the "Number of processors" to 2 (found in the Boot tab and clicking "Advanced options…").

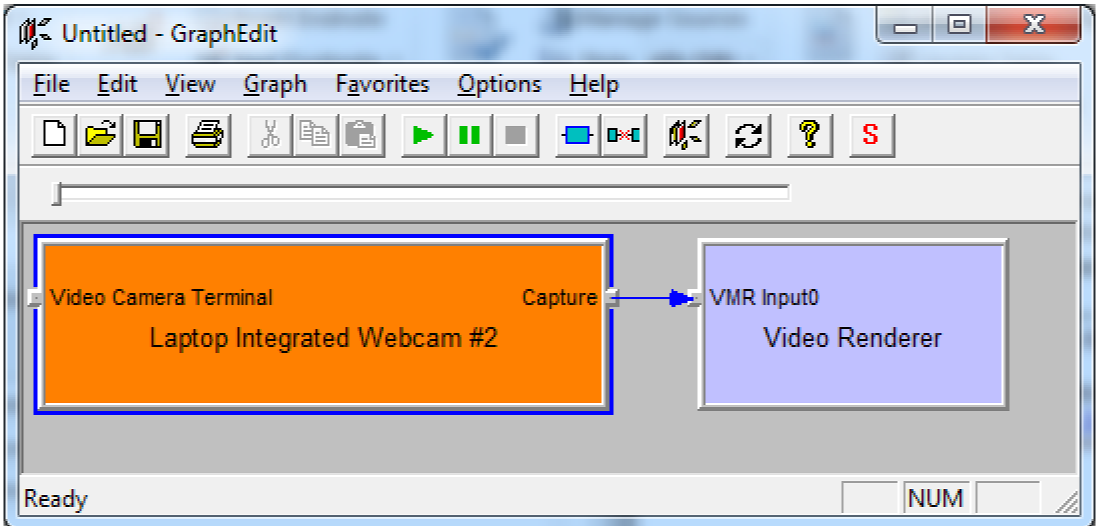


Figure 4: GraphEdit rendering webcam

[2] CIF requires a SmartTee filter before the VMR because of a bug, otherwise the image won't be rendered correctly.

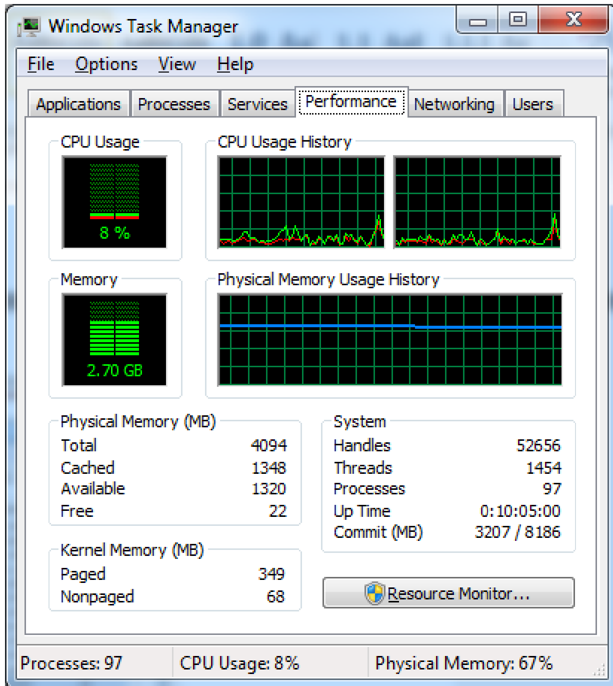


Figure 5: Windows Task Manager

4.1.6 P2: Method to determine camera position, orientation

4.1.6.1 Purpose

Eye gaze has been shown to be important for high task performance and conversational turn taking in video conferencing. However, the non-zero distance between the video capture devices (webcams) and video rendering devices (monitors) creates eye gaze error during video conferencing. The end result is that far-end users looking at remote participants on their monitor don't appear to be looking at the local participant. This artifact is called eye gaze error and can be measured in degrees using the locations of the participants, cameras and displays. Humans are particularly sensitive to eye gaze error and it becomes noticable when it is off by ~2^{o} in the horizontal direction and ~8^{o} in the vertical direction[3][4]. By knowing the camera position with respect to the monitor Lync can position the far end rendered video to minimize eye gaze error.

Camera orientation will be important for Tablet devices and Windows Phones that have cameras in portrait orientation (as well as landscape).

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[3] R.R. Stokes. Human Factors and Appearance Design Considerations of the Mod II PICTUREPHONE Station Set. IEEE Trans. on Communication Technology, COM-17(2), April 1969.

[4] Leveraging the Asymmetric Sensitivity of Eye Contact for Videoconferencing. Milton Chen CHI, 2002

4.1.6.2 Requirements

Notebooks and All-in-One PCs with integrated cameras should follow the Windows 8 Logo camera location requirement. Specifically the camera location is described using ACPI in the following way:

- For any camera device that is built into the chassis of the system and has mechanically fixed direction, the firmware must provide the _PLD method and set the panel field (bits[69:67]) to the appropriate value for the panel on which the camera is mounted. For example, “Front” indicates the camera view the user (webcam), while back “back” indicates that the camera views away from the end user (still or video camera).
- In addition, bit 143:128 (Vertical Offset), and bits 159:144 (Horizontal Offset) must provide the relative location of the camera with respect to the display. This origin is relative to the native pixel addressing in the display component and should match the present display orientation of landscape or portrait. The origin is the lower left hand corner of the display, where positive Horizontal and Vertical Offset values are to the right and up, respectively.

Displays with integrated USB webcams should support the camera location interface defined in Section 5.4.

4.1.6.3 Test procedure

1. Notebooks and All-in-One PCs should run the appropriate Windows Logo Kit test for validating the ACPI camera location.
2. Displays with integrated USB webcams should run TestCameraLocationInterface.exe to test the camera location interface.

4.1.7 P2: Embedded camera shipping protection

4.1.7.1 Purpose

Most notebook and desktop embedded cameras ship with a protective plastic cover. Some of these covers are not noticeable by the user as they are clear and well aligned over the camera cover glass. In addition since the user only sees a preview image they won’t see the full resolution lower quality transmitted image.

4.1.7.2 Requirements

The protective cover should be very obvious to remove. It must not be clear plastic but a colored plastic like blue or yellow. It should have a “Remove” label or icon.

4.1.7.3 Test procedure

1. Examine the DUT’s protective plastic cover. It must not be clear and should include a “Remove” label or icon.

4.2 Video

This section defines video metrics that help ensure good-quality Windows video capture for UC. All tests must be run using both the Windows UVC driver and any supplied video driver.

4.2.1 P1: Latency

4.2.1.1 Purpose

This requirement makes sure the webcam doesn't induce excessive latency in the camera or driver, which would degrade the overall Lync video end-to-end experience. The latency measured is from photons into the webcam to photons out of the display.

4.2.1.2 Requirements

	Non-720p/1080p	**720p/1080p MJPEG**
Video latency	≤ 70 ms	≤ 120 ms

Table 6: Video latency

4.2.1.3 Test setup

Lighting	NA if camera supports manual exposure. Additional lights may be needed on display if exposure isn't fast enough.
Test charts	NA
DUT position	Point tethered cameras at monitor (Figure 6) Embedded notebook cameras should use an external monitor (Figure 7)
DUT settings	Autofocus set to manual to minimize focus swimming Exposure set to 1/256 sec (approximately)[5] to minimize motion blur Gain set to maximum value

Table 7: Video latency test setup

4.2.1.4 Test procedure

1. For each P1 resolution and max frame rate:
    a. Run LyncVidCap and select Settings | Measure Latency.
    b. Point the camera at the Latency window (see Figure 6).
    c. Focus the camera
    d. Read off the Video Latency in the LyncVidCap window.

Notes:

- A quad core PC should be used for 1080p and 720p tests.
- A mirror can be used for notebook computers with integrated cameras so that the screen can be imaged.

[5] The camera exposure setting should be an integer n, where the exposure is 2^{-n} seconds. See ICameraControl::get_Exposure.

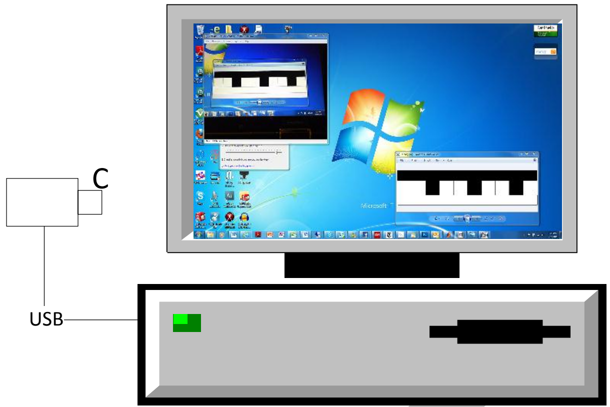

Figure 6: Video latency test setup with an external camera

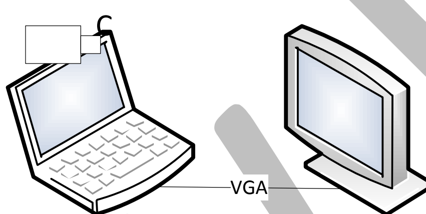

Figure 7: Video latency test setup with a notebook integrated camera

4.2.2 P1: Jitter

4.2.2.1 Purpose
Ensure the webcam and drivers don't have excessive jitter.

4.2.2.2 Requirements
The jitter at all P1 resolutions and max frame rates must be ≤ 7 ms.

4.2.2.3 Test setup

Lighting	3500 K test lighting (Figure 52), 200 +/- 20 lux at target
Test charts	ST-52
DUT position	Pointed at ST-52, 0.5m from target
DUT settings	Default

Table 8: Jitter test setup

4.2.2.4 Test procedure
1. For each P1 resolution and max frame rate, do the following:
    a. Run LyncVidCap and render the captured video.
    b. Render the video for 30 seconds.
    c. Read the Jitter on the LyncVidCap Statistics. Compare this value to the requirements.

Note: Jitter can be affected if the max frame rate is not achieved.

4.2.3 P1/P2: Time to capture first image, change resolutions

4.2.3.1 Purpose
The time to capture the first image is important to minimize delay seen by the user and to facilitate dynamic changing of resolutions in future versions of Microsoft Lync.

4.2.3.2 Requirements
The requirements for all P1 resolutions and max frame rates are given in Table 9.

	Basic/Standard	Premium	Priority
Time to capture first image	≤ 1500 ms	≤ 500 ms	1
Time to change resolutions	≤ 250 ms	≤ 250 ms	2

Table 9: Time to capture first image requirements

4.2.3.3 Test setup

Lighting	3500 K test lighting (Figure 52), 200 +/- 20 lux at target
Test charts	ST-52 chart
DUT position	Pointed at ST-52, 0.5m from target
DUT settings	Default

Table 10: Time to capture first image test setup

4.2.3.4 Test procedure
1. For each P1 resolution and max frame rate:
    a. Run LyncVidCap and select Settings | Latency and deselect Capture | Preview.
    b. Point camera at screen centered Latency window (see Figure 6).
    c. Select Capture | Preview
    d. Read off the Time to Capture First Image in the LyncVidCap window.
2. For each P1 resolution and max frame rate:
    a. Run LyncVidCap and select Settings | Resolution Change Latency and deselect Capture | Preview.
    b. Point camera at screen centered Latency window (see Figure 6).
    c. Change the resolution to other supported resolutions.
    d. Select Capture | Preview
    e. Read off the Time to Change Resolution in the LyncVidCap window.

4.2.4 P1/P2: Image resolutions, frame rates, color spaces

4.2.4.1 Purpose
This test ensures that required and recommended image resolutions, native frame rates, and color spaces are supported.

4.2.4.2 Requirements

Resolution	Frame rates	Color space	Priority
352x288	15 and 30	YUY2	1
		I420 or M420	2
	25[6]	YUY2	2
640x480	15 and 30	YUY2	1
		I420 or M420	2
	25	YUY2	2

Table 11: 4:3 aspect ratio video

Resolution	Frame rates	Color space	Priority
1920x1080[7]	15 and 30	MJPEG or YUY2	1
1280x720	15 and 30	MJPEG or YUY2	1
	15	I420 or M420	2
960x540	15 and 30	I420, M420 or MJPEG	1
640x360	15 and 30	YUY2, I420 or M420	1
424x240	15	YUY2, I420 or M420	1

Table 12: 16:9 aspect ratio video for HD webcams

Note: Microsoft Lync will open a 1280x720 webcam in 720p mode if the PC has 4 cores or more and the webcam supports ≥ 15 FPS. It is critical that webcams do not expose 1280x720 modes if 15 FPS can't be met in the lighting conditions given in Table 15.

Webcams that are external devices will be tested under all available P1 resolutions and color spaces. Webcams that are embedded in a system (for example, Lync PCs) must test the resolutions given in Table 13:

Physical CPU Cores	**1**	**2**	**4**
W13 P2P	CIF	VGA	720p
W13 Conf	CIF	CIF	CIF
W14 P2P	CIF	VGA	720p
W14 Conf	CIF	VGA	VGA
Resolutions to test	**CIF**	**CIF and VGA**	**CIF, VGA, and 720p**

Table 13: Embedded P1 resolutions to test

For example, a system with a dual core CPU will be tested under CIF and VGA resolutions but not 720p, while a quad core system will be tested under all three resolutions unless the camera does not announce all three.

[6] 25FPS is used for Office Communicator 2007R2 only; later versions of Lync use 30FPS.
[7] 1080p only required if webcam supports it. HD webcams can be 1080p or 720p. 1080p is for future versions of Lync. 1080p and 720p can support YUY2 30FPS with USB 2.0 only if sent as MJPEG and then decoded in the driver.

The webcam must set the UVC Color Matching Descriptor to the following values:

- Uncompressed frame type
  - bColorPrimaries=1 (BT.709, sRGB)
  - bTransferCharacteristics=1 (BT.709)
  - bMatrixCoefficients=4 (BT.601)
- MJPEG frame type
  - bColorPrimaries=1 (BT.709, sRGB)
  - bTransferCharacteristics=1 (BT.709)
  - bMatrixCoefficients=4 (BT.601)

The luminance and chrominance ranges for supported color spaces are given in Table 14.

Color space	Luminance	Chrominance
YUY2	16-235	16-240
MJPEG	0-255	0-255
I420	16-235	16-240
M420	16-235	16-240

Table 14: Luminance and chrominance ranges

Table 15 gives the minimum frame rates required for various lighting levels.

Lighting (lux)	Frame rate (FPS)
50	≥ 15 +/- 1
200	30 +/- 1 (or max)

Table 15: Minimal frame rates

4.2.4.3 Test setup

Lighting	3500 K test lighting (Figure 52), 200 +/- 20 lux, 50 +/- 5 lux at target
Test charts	ST-52
DUT position	Pointed at ST-52, 0.5m from target
DUT settings	Default

Table 16: Image resolutions, frame rates, color spaces test setup

4.2.4.4 Test procedure

4.2.4.4.1 Frame rate

1. For each P1 resolution, max frame rate, and color space combinations:
   a. In 50 lux lighting:
      i. Run LyncVidCap, select the resolution and max frame rate, color space.
      ii. View the video for 30 seconds.
      iii. Read the actual frame rate from the LyncVidCap window and compare to Table 15.
   b. In 200 lux lighting:

i. Repeat steps a.i to a.iii.

4.2.4.4.2 bMatrixCoefficients

1. For each P1 resolution:
    a. Run UVCView and read bMatrixCoefficients for the uncompressed frame type (in the "===>Color Matching Descriptor<=== " block below "===>Video Streaming Uncompressed Frame Type Descriptor<===") and MJPEG frame type (in the "===>Color Matching Descriptor<=== " below the "===>Video Streaming MJPEG Frame Type Descriptor<===" block).

4.2.4.4.3 Color limits

1. For each P1 resolution
    a. Run LyncVidCap, select the resolution and frame rate, color space.
    b. Select Settings| Color Limits
    c. Read the color limits from the LyncVidCap window

4.2.5 P1: Image resolution quality (MTF, oversharpening, edge roughness)

4.2.5.1 Purpose

This test ensures that images provide a basic level of image acuity (for example, the lens is sharp enough for the sensor, and the sensor has enough pixels to capture the desired resolution after demosaicing and image processing). MTF30 is one good measure of acuity, but can be defeated by sharpening the image after capture via image processing. Oversharpening (and undersharpening) is a measure to ensure that cameras are not using too much sharpening (or not enough), which induces image artifacts like ringing or fuzzy images. Edge roughness is a measure of image scaling quality (for example, bilinear is greatly preferred over nearest neighbor, and bicubic is preferred over bilinear).

Related standard: ISO 12233-2000.

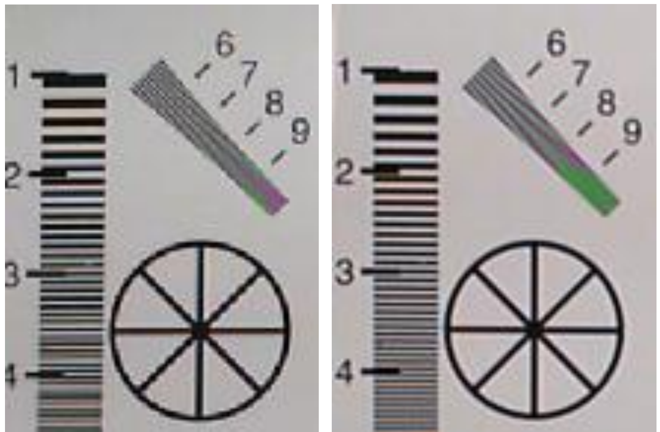

Figure 8: Left: VGA image from a 720p webcam, edge roughness=0.151; Right: VGA image from the same 720p webcam scaled using bicubic with anti-aliasing[8], edge roughness=0.033.

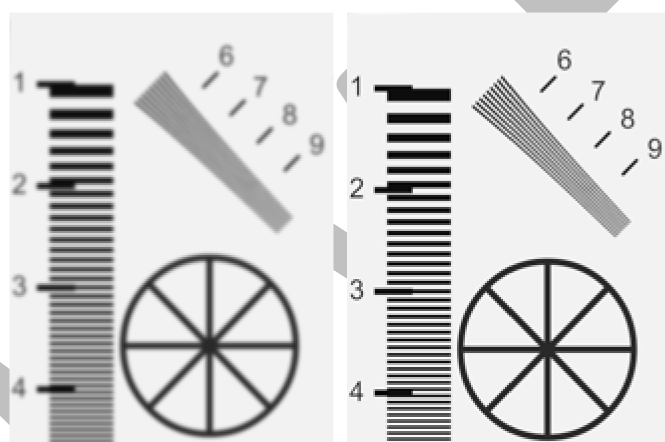

Figure 9: Left: MTF30=0.292, oversharpening=-27%; Right: MTF30=0.626, oversharpening=-1.9%

Figure 10: Left: Oversharpening=51.8%; Right: oversharpening=10.1%

[8] Note this image still has a lot of color artifacts as the camera uses a 1280x720 sensor with no optical antialiasing filter and therefore has demosiacing color aliasing artifacts.

Requirements

	Basic	Standard	Premium
MTF30 (horizontal and vertical)	0.3 ≤ MTF30 ≤ 0.9	0.3 ≤ MTF30 ≤ 0.8	0.4 ≤ MTF30 ≤ 0.7
Absolute_Value(Oversharpening)	≤ 25%	≤ 20%	≤ 15%
RMS edge roughness	≤ 0.15	≤ 0.1	≤ 0.05

Table 17: MTF and edge oversharpening requirements

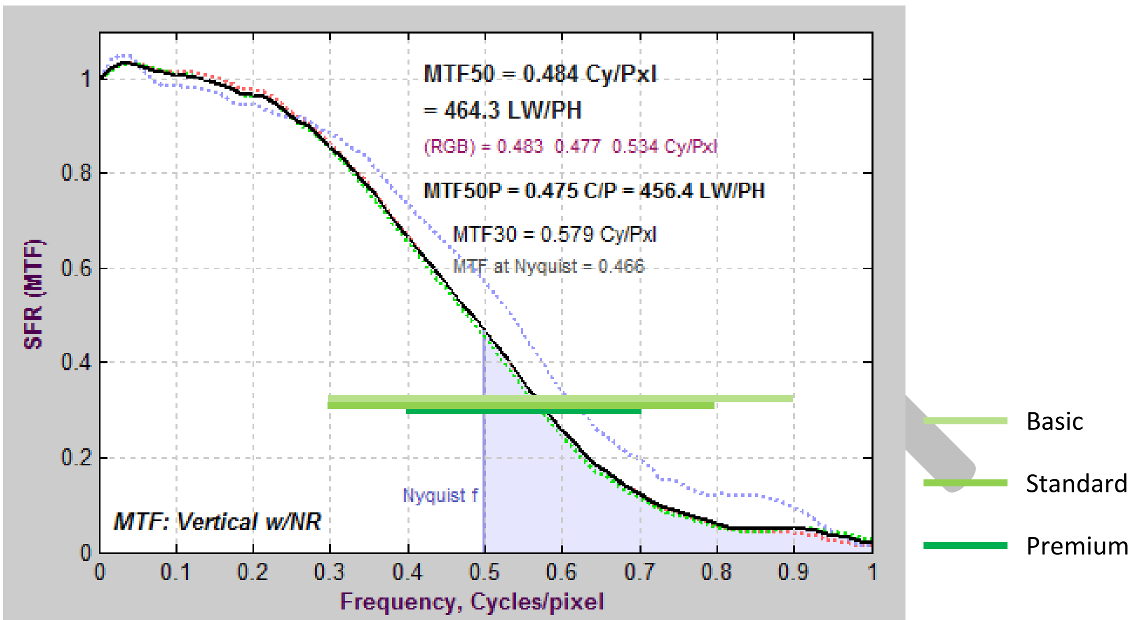

Figure 11: MTF30 criteria shown in a typical Premium webcam

4.2.5.2 *Test setup*

Lighting	3500 K test lighting (Figure 52), 200 +/- 20 lux at target
Test charts	Slanted edge test chart (see Figure 53)
DUT position	Pointing at test chart at a distance of 0.5 m Ensure camera has <1% rotational error with respect to horizon Make target edge within +/- 20% of image center
DUT settings	Default

Table 18: Image resolutions, frame rates, color spaces test setup

4.2.5.3 *Test procedure*

1. For each P1 resolution and max frame rate, capture an image of the resolution chart:
    a. Run Imatest SFR on the captured image and select a horizontal edge in the center of the image (see Figure 12). Be sure to check the following:
        i. Align the red cross hair in the ROI to the edge. Not doing this results in inaccurate results.
        ii. The minimum region of interest size should be 60x40 or 40x60. Smaller sizes will result in reduced accuracy.

iii. Image is not under or oversaturated (see Figure 14). Imatest will report "Clipping" if the image is under or oversaturated.

iv. Edge angle is 5^{o} +/- 1^{o} (see Figure 14). If the angle reported by Imatest is not within this tolerance, reposition the DUT so this tolerance is met and run the test again.

b. In the "SFR settings and options" dialog box (Figure 13)

i. Select cycles/pixel

ii. Select display oversharpening only

c. Read off the MTF30, edge roughness, and oversharpening from the Cycles/Pixel window (see Figure 14).

Note: watch for clipping in Figure 14. See Imatest documentation for further details.

d. Repeat 3 and 4 for a vertical edge (see Figure 15).

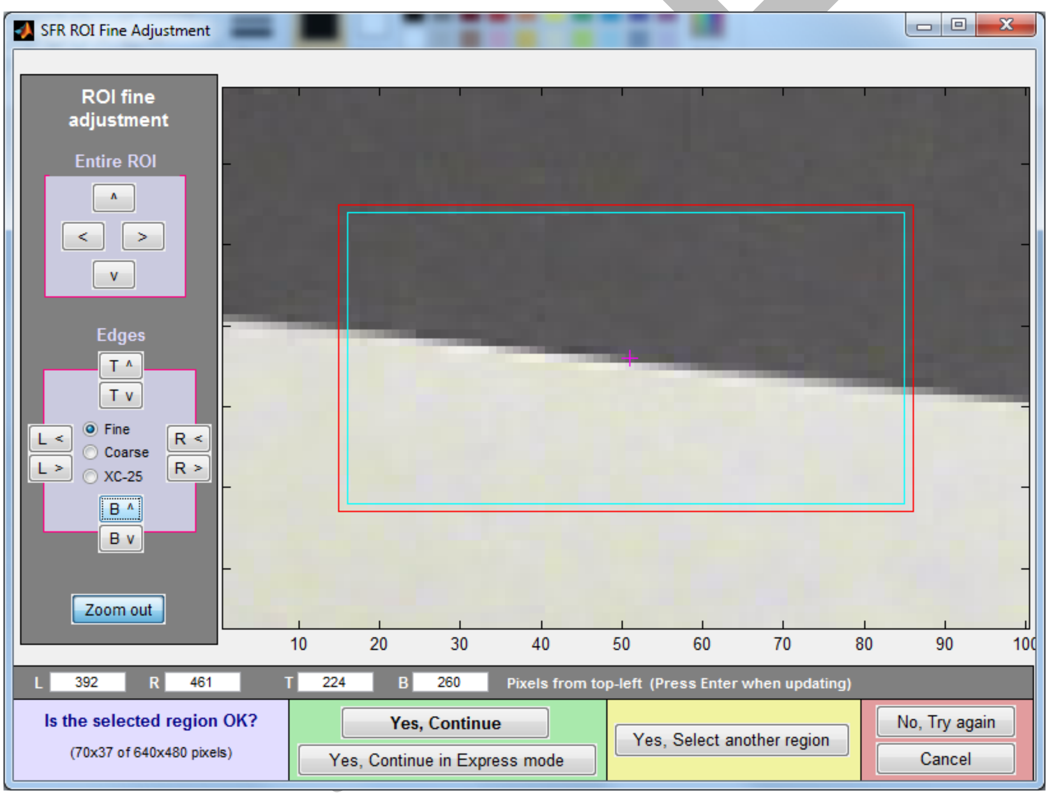

Figure 12: Vertical SFR ROI

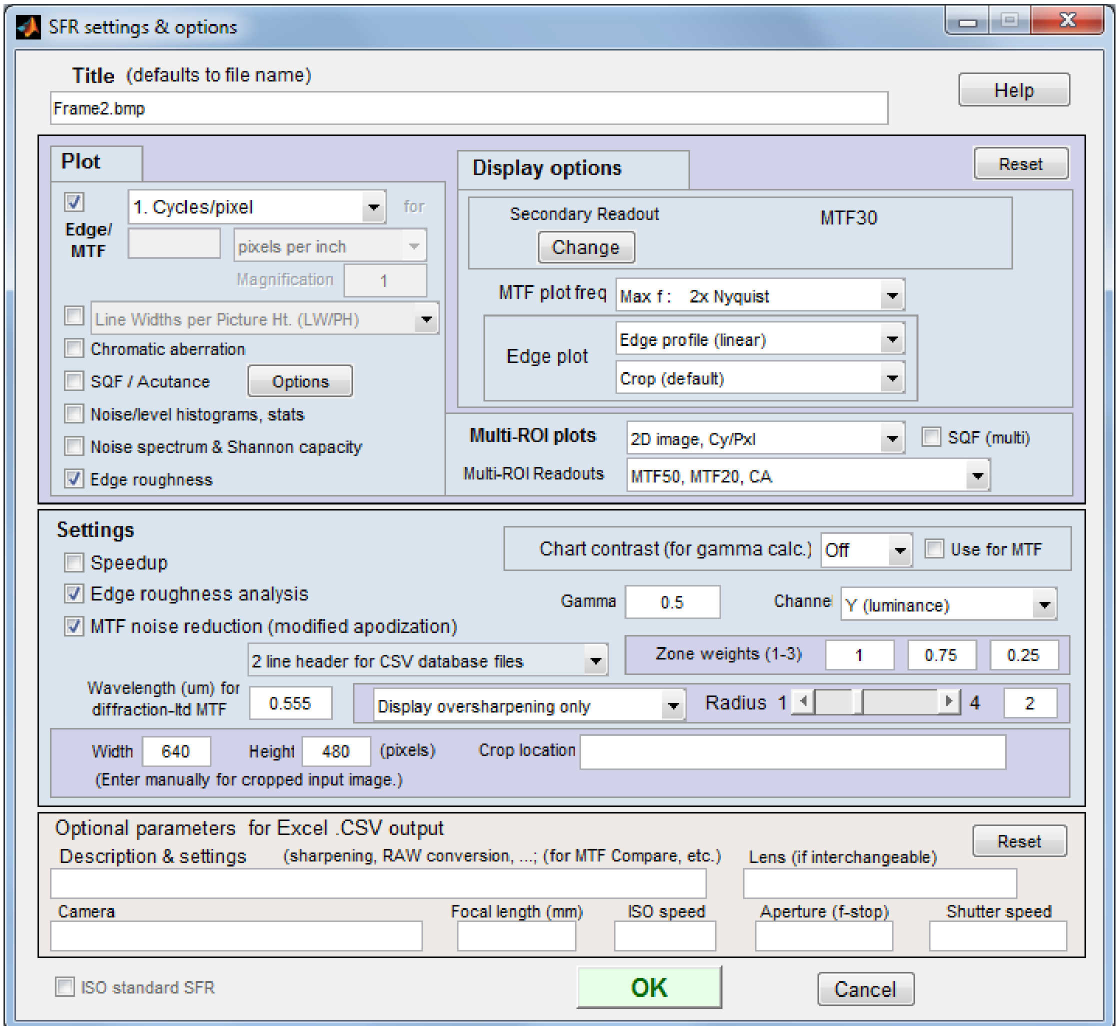

Figure 13: Imatest SFR setup

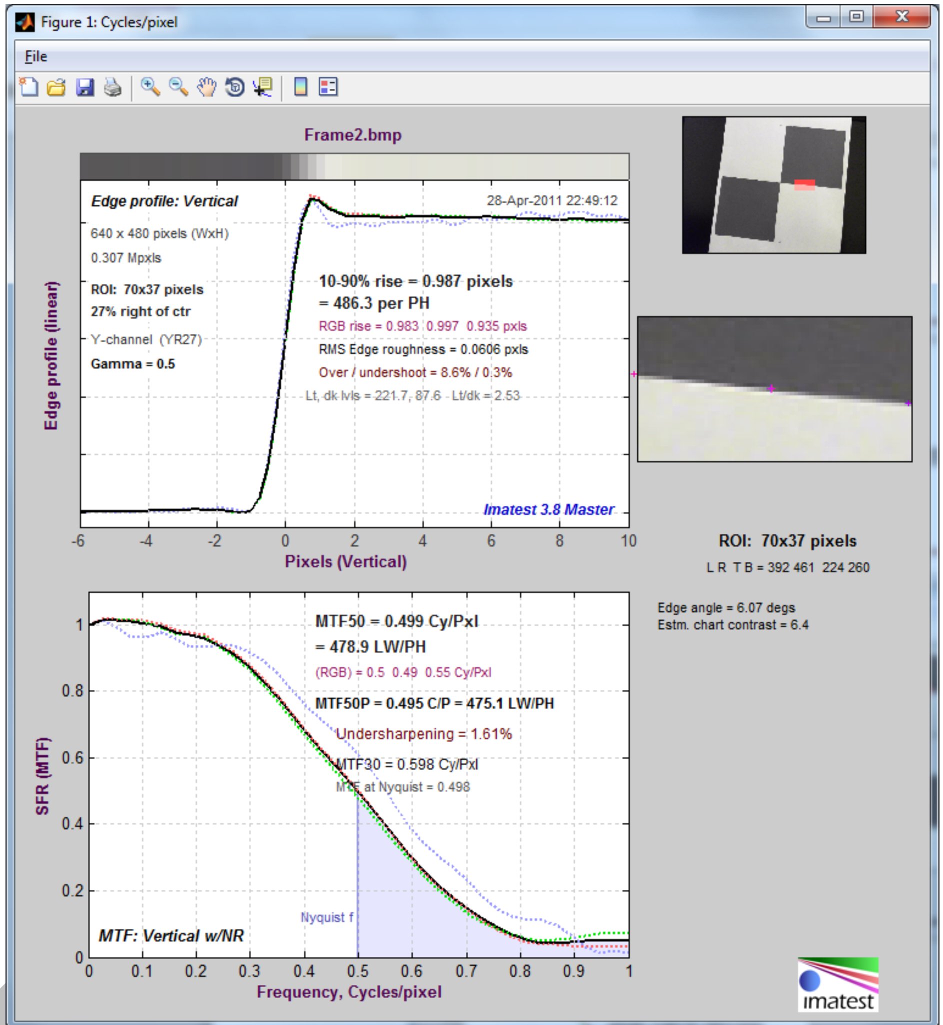

Figure 14: Imatest SFR results

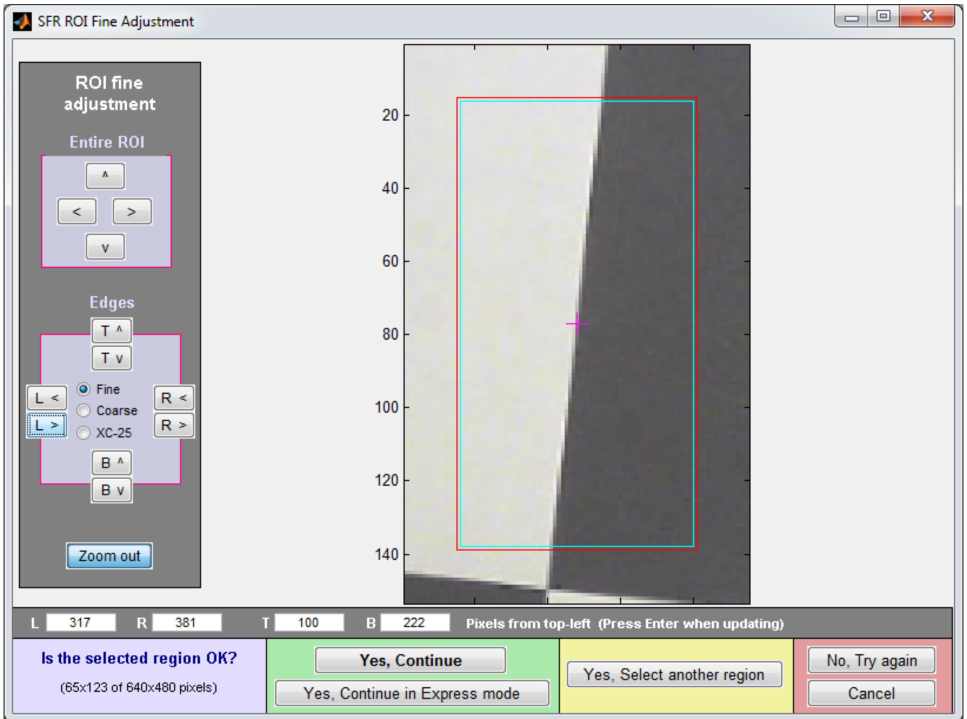

Figure 15: Horizontal SFR ROI

4.2.6 P1: Image dynamic range

4.2.6.1 Purpose

Sufficient dynamic range is required to capture the user and background without significant saturation. This test measures dynamic range in the test lighting setup (Figure 52).

Related standard: ISO 15739-2003.

Figure 16: Left: dynamic range=33dB, Right: dynamic range=43 dB

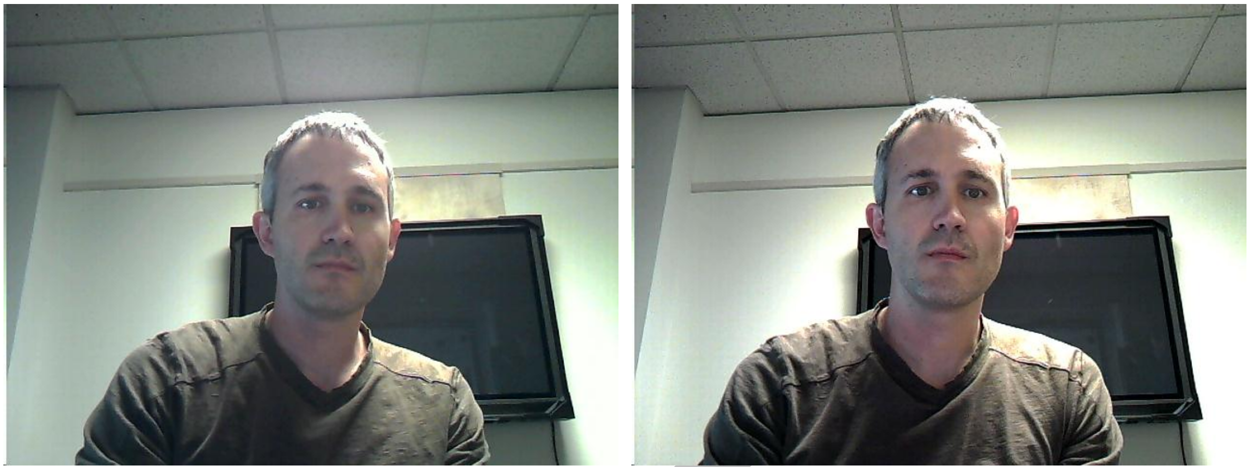

Figure 17: Left: Notebook webcam image with typical room lighting; Right: same camera with simple lens hood added, which improves the dynamic range by 8 dB; good anti-reflective coatings can have the same improvement.

4.2.6.2 Requirements

	Basic	Standard	Premium
Dynamic range	≥ 33 dB	≥ 36 dB	≥ 42 dB

Table 19: Image DR

4.2.6.3 Test setup

Lighting	3500 K test lighting (Figure 52), 200 +/- 20 lux at target
Test charts	ST-52
DUT position	Pointing at test chart at a distance of 0.5 m
DUT settings	Default

Table 20: Image dynamic range test setup

4.2.6.4 Test procedure

1. For each P1 resolution and max frame rate:
    a. Capture an image.
    b. Run Imatest and select the Stepchart analysis module.
    c. Adjust the ROI and select “Noise in pixels (max 255)” and “Pixel SNR (dB) (20*log10(S/N))” (see Figure 18).
    d. Do fine adjustments for the ST-52 ROI (see Figure 19).
    e. Read “Total dynamic range” in f-stops from “Stepchart noise detail” (see Figure 20); multiply this number by 6.02 to get dB and compare with criteria.

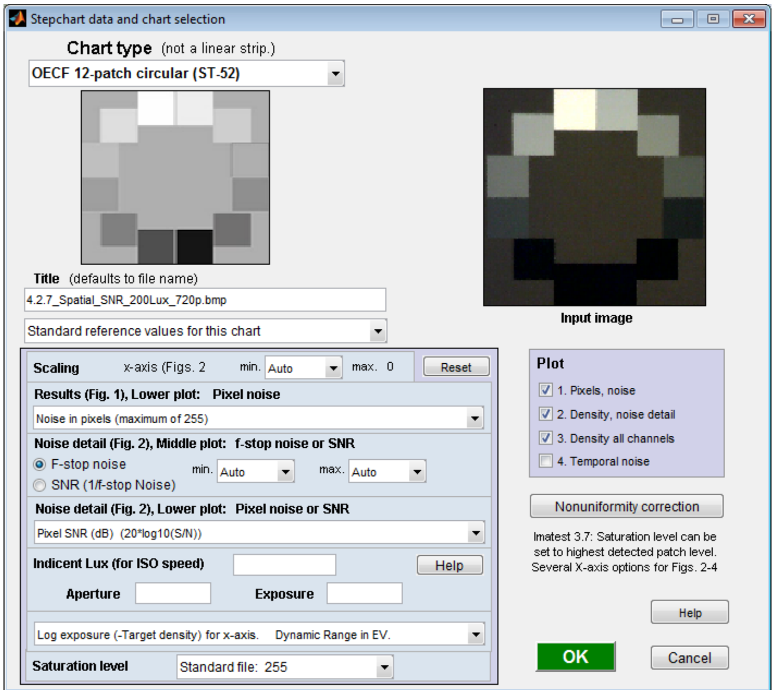

Figure 18: Imatest setup for dynamic range test

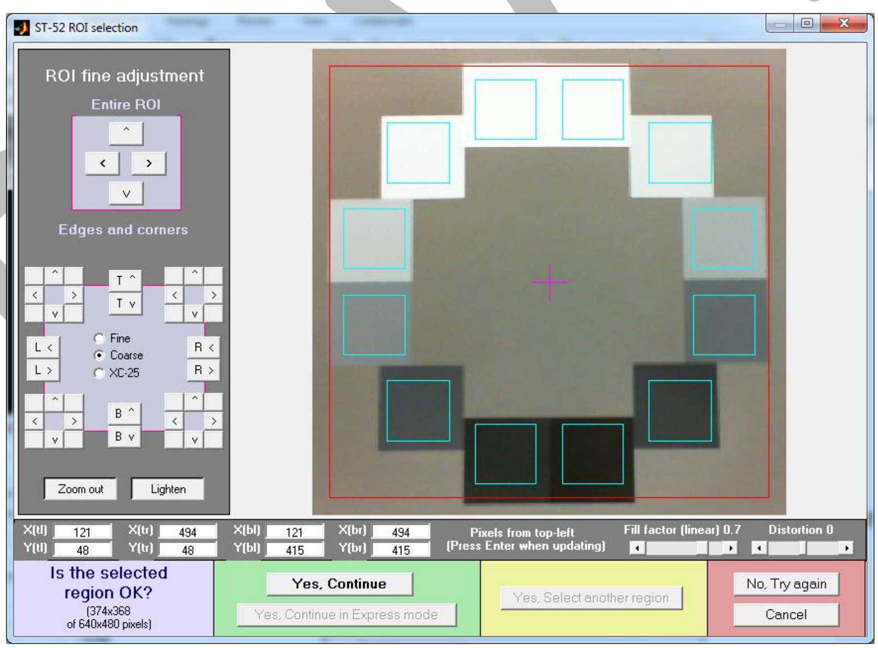

Figure 19: Imatest setup for dynamic range test

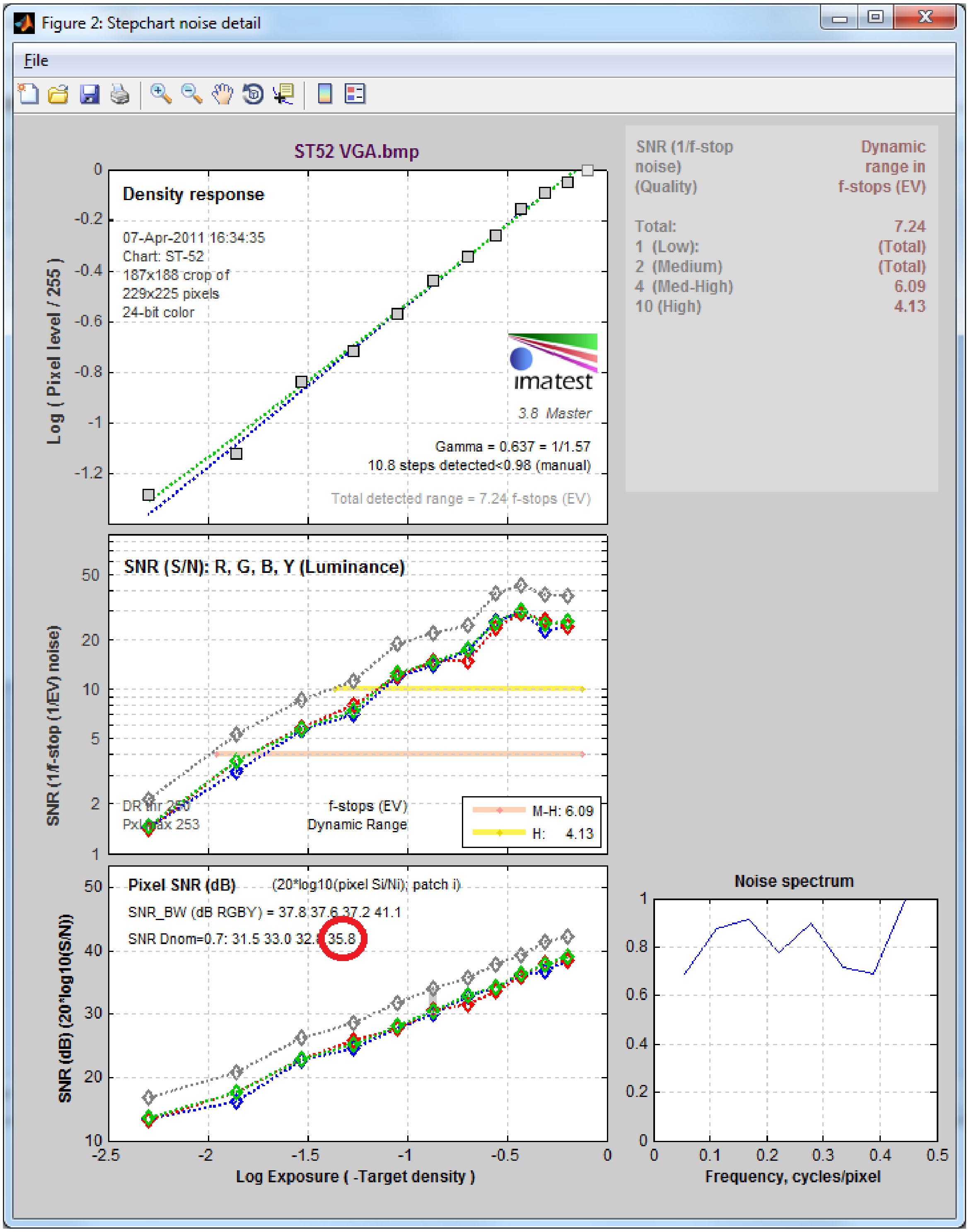

Figure 20: Imatest dynamic range results

4.2.7 P1: Image spatial SNR

4.2.7.1 *Purpose*

Sufficient spatial signal-to-noise ratio is required for images to not look too noisy and for good video compression efficiency.

Related standard: ISO 15739-2003

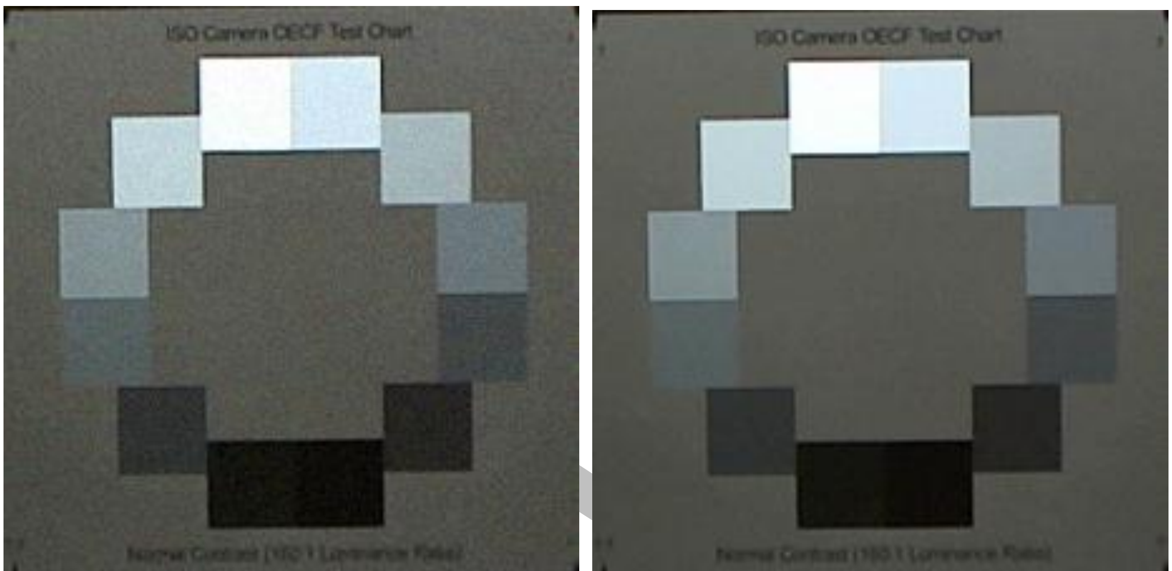

Figure 21: Left: SNR=27.6 dB; Right: SNR=36.8 dB

4.2.7.2 *Requirement*

	Basic/Standard	Premium
SNR 50 lux	≥ 30 dB	≥ 33 dB
SNR 200 lux	≥ 33 dB	≥ 36 dB

Table 21: Image spatial SNR

4.2.7.3 *Test setup*

Lighting	3500 K test lighting (Figure 52), 200 +/- 20 lux, 50 +/- 5 lux at target
Test charts	ST-52
DUT position	Pointing at test chart at a distance of 0.5 m Ensure minimal keystoning (perspective distortion) with chart
DUT settings	Default

Table 22: Image spatial SNR test setup

4.2.7.4 *Test procedure*

1. For 50 lux setup: for each P1 resolution and max frame rate:
    a. Capture an image.
    b. Run Imatest and select the Stepchart analysis module.

   c. Adjust the ROI and select "Noise in pixels (max 255)" and "Pixel SNR (dB) (20*log10(S/N))" (see Figure 18).
   d. Do fine adjustments for the ST-52 ROI (see Figure 19).
   e. Read the spatial,l SNR (density 0.7) in "Stepchart noise detail" figure (see Figure 20). It is called "Dnom=0.7" and is the last (4th) value in a list, highlighted in red. Enter this value in the Excel workbook template and compare the results with the criterion.
2. Repeat for 200 lux.

4.2.8 P1: Image temporal SNR

4.2.8.1 Purpose

Sufficient temporal signal-to-noise ratio is required for images to not look too noisy and for good video compression efficiency.

Related standard: ISO 15739-2003.

4.2.8.2 Requirement

	Basic/Standard	Premium
SNR 50 lux	≥ 30 dB	≥ 33 dB
SNR 200 lux	≥ 33 dB	≥ 36 dB

Table 23: Image temporal SNR

4.2.8.3 Test setup

Lighting	3500 K test lighting (Figure 52), 200 +/- 20 lux, 50 +/- 5 lux at target
Test charts	ST-52
DUT position	Pointing at test target at a distance of 0.5 m
DUT settings	Exposure, gain, white balance set to manual

Table 24: Image temporal SNR test setup

4.2.8.4 Test procedure

1. For 50 lux setup: For each P1 resolution and max frame rate
   a. Capture two images of stepchart in rapid succession (ensure no lighting change occurs).
   b. Run Stepchart analysis and select the two image files captured in the previous step.
   c. Select "Read two files for measuring temporal noise" (see Figure 22).
   d. Select "Noise in pixels (max 255)" and "Pixel SNR (dB) (20*log10(S/N))" as shown in Figure 23.
   e. Adjust the region of interest as shown in Figure 19.
   f. Read the spatial,l SNR (density 0.7) in "Stepchart noise detail" figure (see Figure 24). It is called "Dnom=0.7" and is the last (4th) value in a list, highlighted in red. Enter this value in the Excel workbook template and compare the results with the criterion.
2. Repeat for 200 lux.

Notes:

- If the camera doesn't support manual exposure/gain/white balance, then the temporal results might not be accurate (it will likely degrade the results). Continue with the test but make a note in the Excel workbook template.

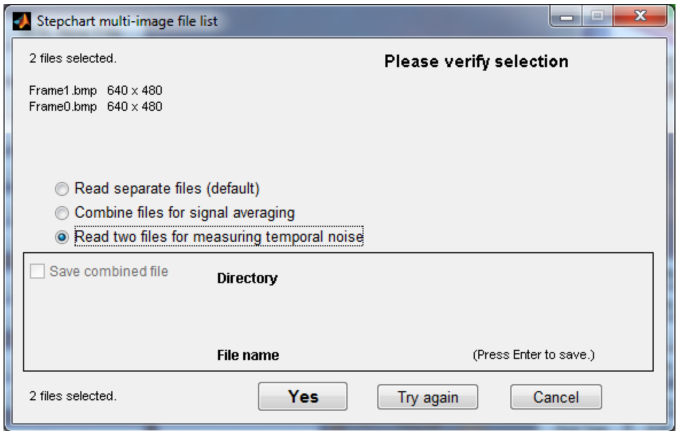

Figure 22: Imatest temporal SNR setup

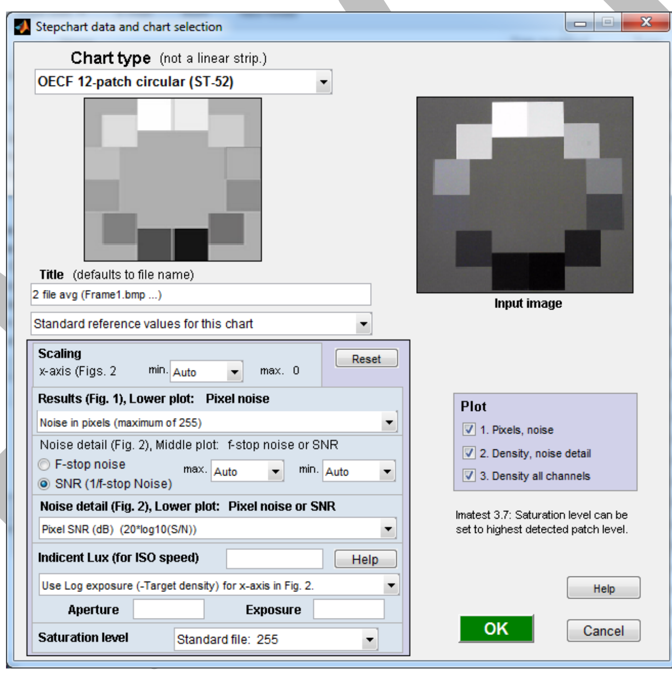

Figure 23: Imatest temporal SNR setup

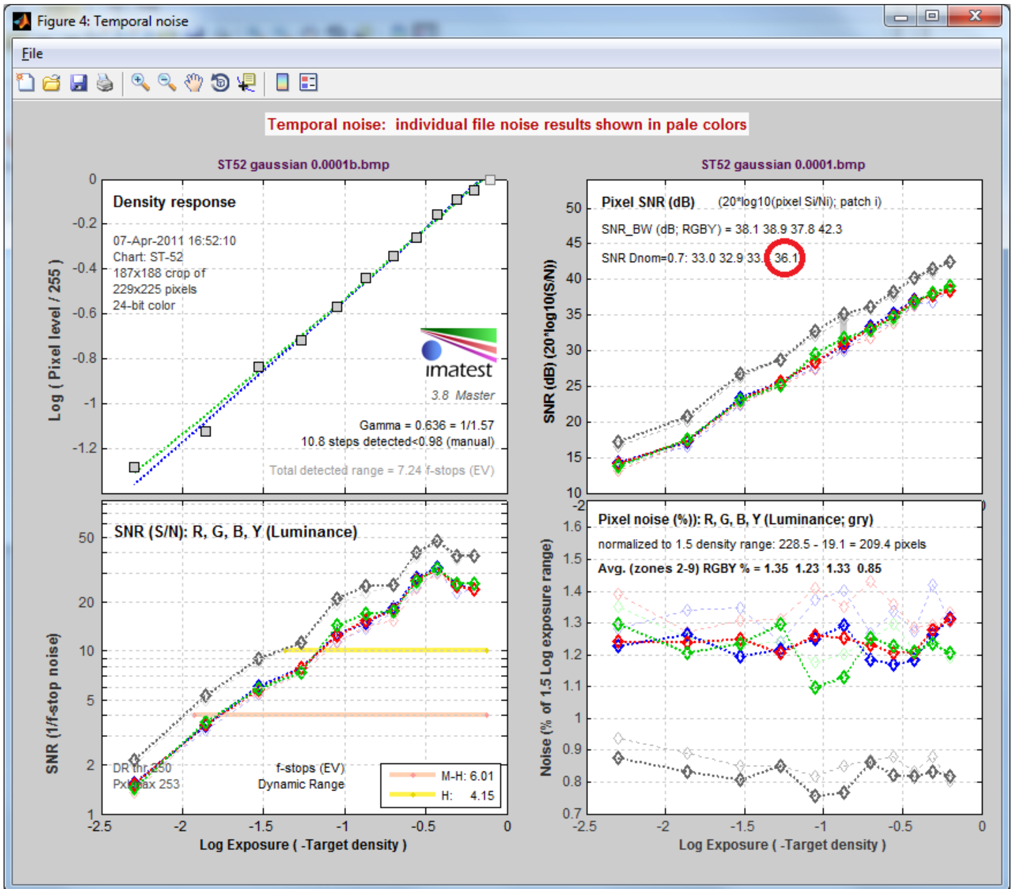

Figure 24: Imatest temporal SNR results

4.2.9 P1: Gamma

4.2.9.1 Purpose

Windows monitors and projectors are standardized to have a gamma of 2.2 (via sRGB), so a camera gamma of 0.45 ensures a linear image capture to image render system. Gamma >> 0.45 can give images that have excessive contrast and look unnatural due to the non-linear color mapping.

Related standard: ISO 14524-1999.

Figure 25: Left: gamma=0.5, Right: gamma=0.75

4.2.9.2 Requirements

	Basic	Standard/Premium
Gamma	[0.4,0.75]	[0.4,0.65]

Table 25: Gamma

4.2.9.3 Test setup

See Section 4.2.6. Only the 200-lux light setup needs to be used.

4.2.9.4 Test procedure

1. Do test procedure in Section 4.2.6.4.
2. Read off gamma from "Stepchart results" (see Figure 26).

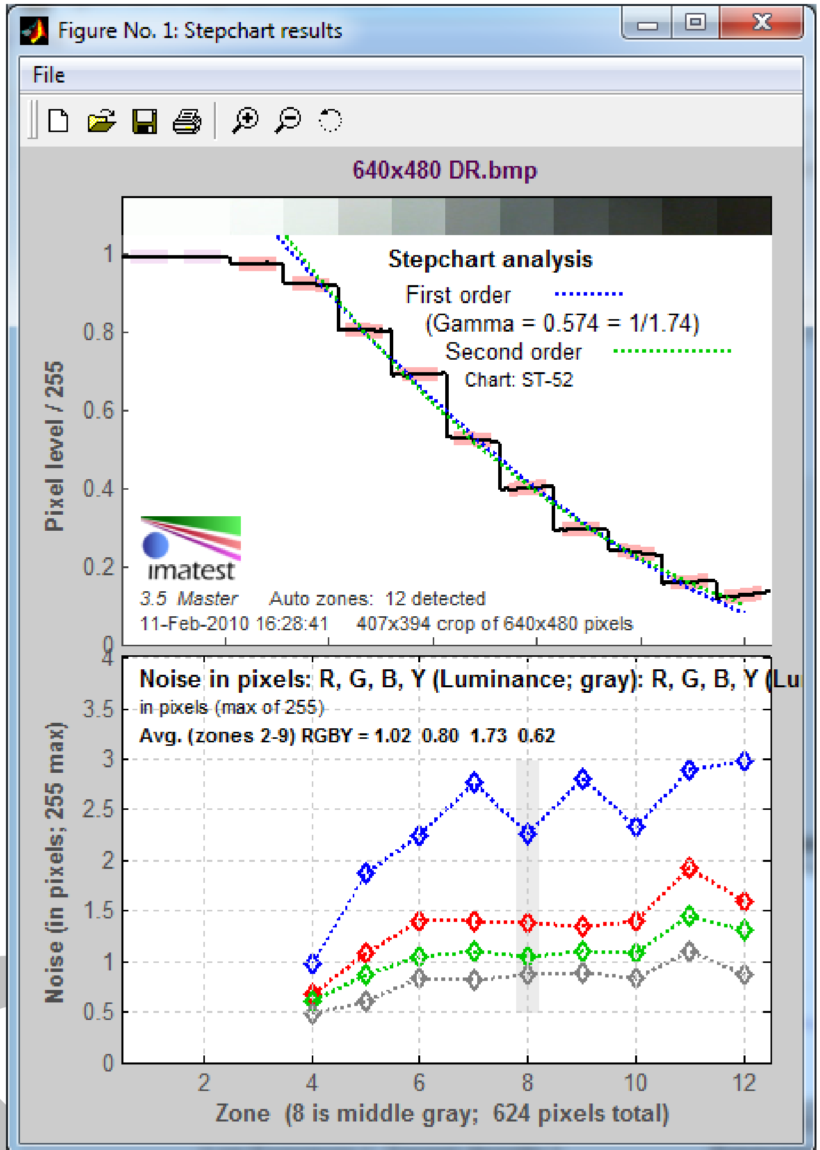

Figure 26: Imatest gamma results

4.2.10 P1: Relative illumination

4.2.10.1 Purpose

This test checks that a relatively uniform image of the user and the background is captured. Relative illumination ensures that the luminance is uniform across the image. Color uniformity ensures that the color is uniform across the image.

Related standards: CPIQ Phase 2 – Color Uniformity.

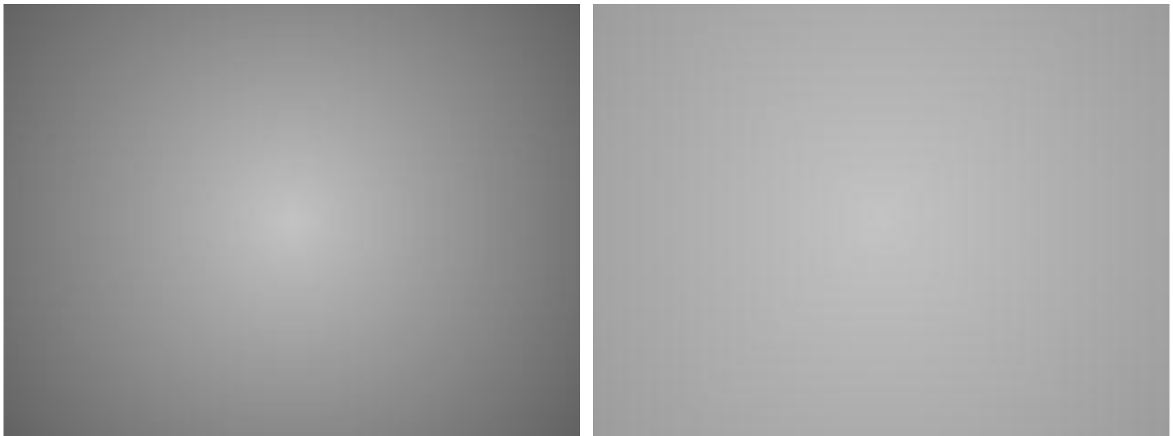

Figure 27: Left: Relative illumination=65%; Right: Relative illumination=86%

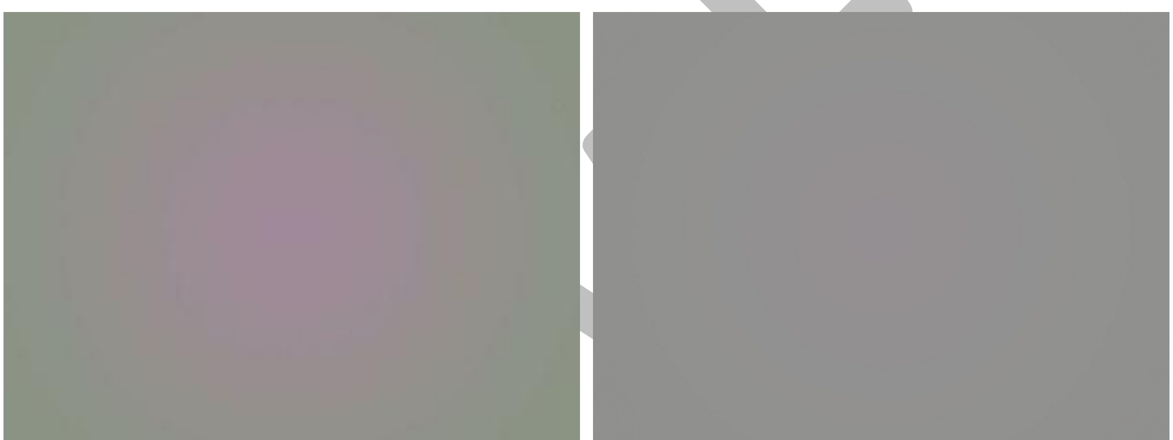

Figure 28: Left: Max ΔC=12.3; Right: Max ΔC=3.2

4.2.10.2 Requirements

	Basic	**Standard**	**Premium**
Relative illumination	60% $\leq$ RI $\leq$ 140%	70% $\leq$ RI $\leq$ 130%	80% $\leq$ RI $\leq$ 120%
Color uniformity	Max $\Delta C \leq 15$	Max $\Delta C \leq 10$	Max $\Delta C \leq 5$

Table 26: Relative illumination and color ratios

4.2.10.3 Test setup

Lighting	Integrating sphere or opal glass with 3500 K test lighting (Figure 52)
Test charts	NA
DUT position	In integrating sphere or uniform light source (see Section 4.5.1)
DUT settings	Default

Table 27: Relative illumination test setup

4.2.10.4 Test procedure

1. For each P1 resolution and max frame rate:

a. Capture an image.
b. Run Imatest, select the Light Falloff module, and read the captured image.
c. Select the entire image as the ROI.
d. Select "Display pixel contours only" and Channel: "Y" (see Figure 29).
e. Select "20:15" for 4:3 images or "32:18" for 16:9 images.
f. Using the "Luminance contours" result window (see Figure 30) use the minimum of corners or sides relative illumination (percentage). Compare these with the criteria.
g. Using the "Grid Sector plot" result window (see Figure 31) read off the Max ΔC and enter it into the Excel workbook template. Compare the results to the criteria.

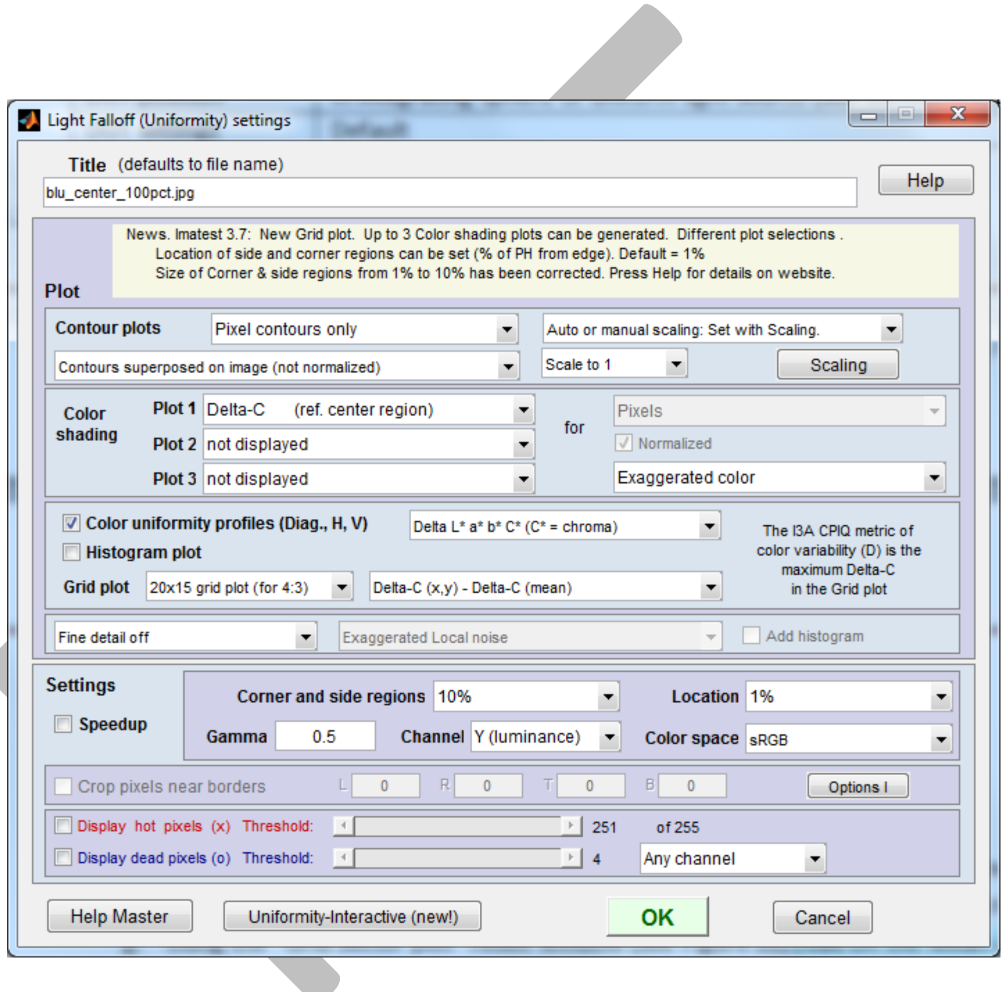

Figure 29: Imatest relative illumination setup

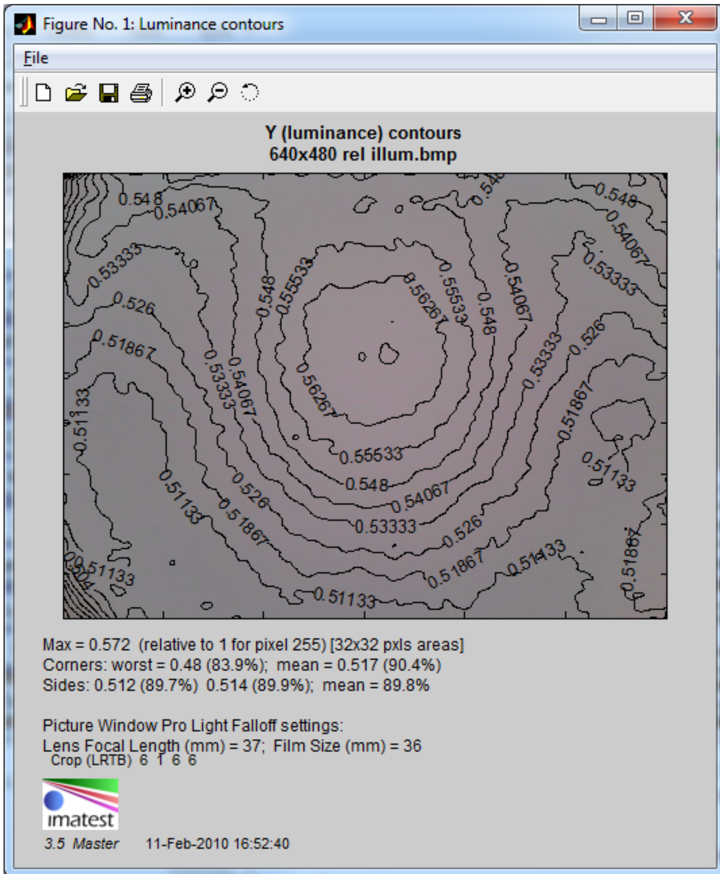

Figure 30: Imatest relative illumination test results

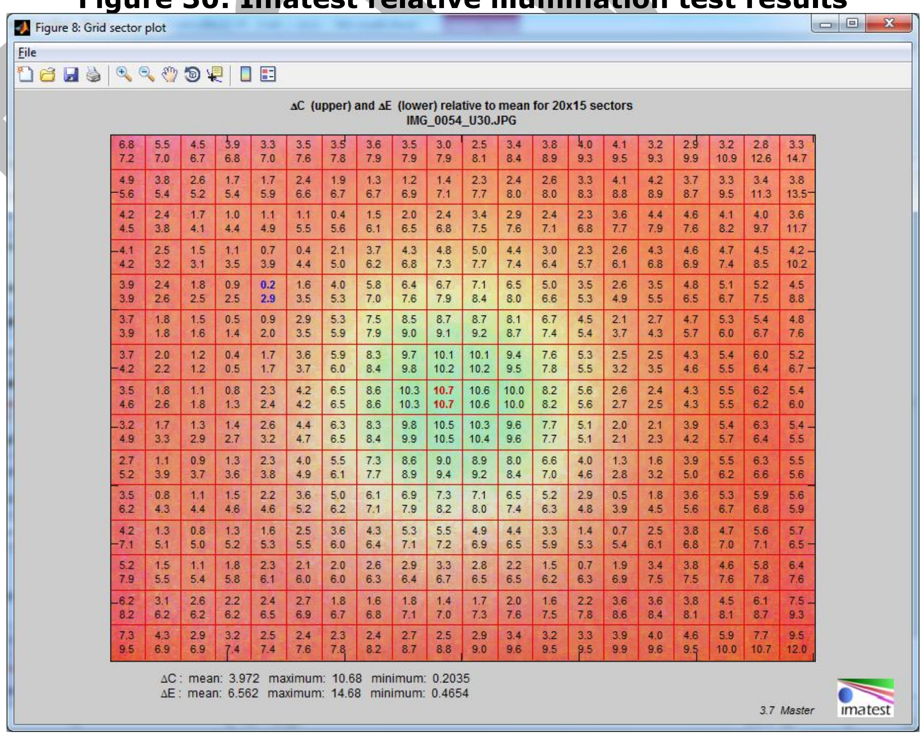

Figure 31: Imatest color uniformity test

4.2.11 P1: Field of view

4.2.11.1 Purpose

This test ensures that the camera has sufficient field of view (FOV) to capture the "talking head" scenario (a person in front of a PC). See Figure 32 for a typical notebook user scenarios and the Vertical FOV (VFOV). Note that notebook webcams typically point orthogonal to the screen and screen needs to be pointed down at a non-optimal viewing angle in order for the camera FOV to image the head and upper torso. An ideal integrated notebook webcam would have an adjustable tilt angle so that the display angle and camera angle can be simultaneously optimized. While a VFOV=40^{0} captures the head and shoulders for this scenario, a VFOV=60^{0} with a 10^{0} down look angle is required to capture the body gestures, which are an important part of non-verbal communication.

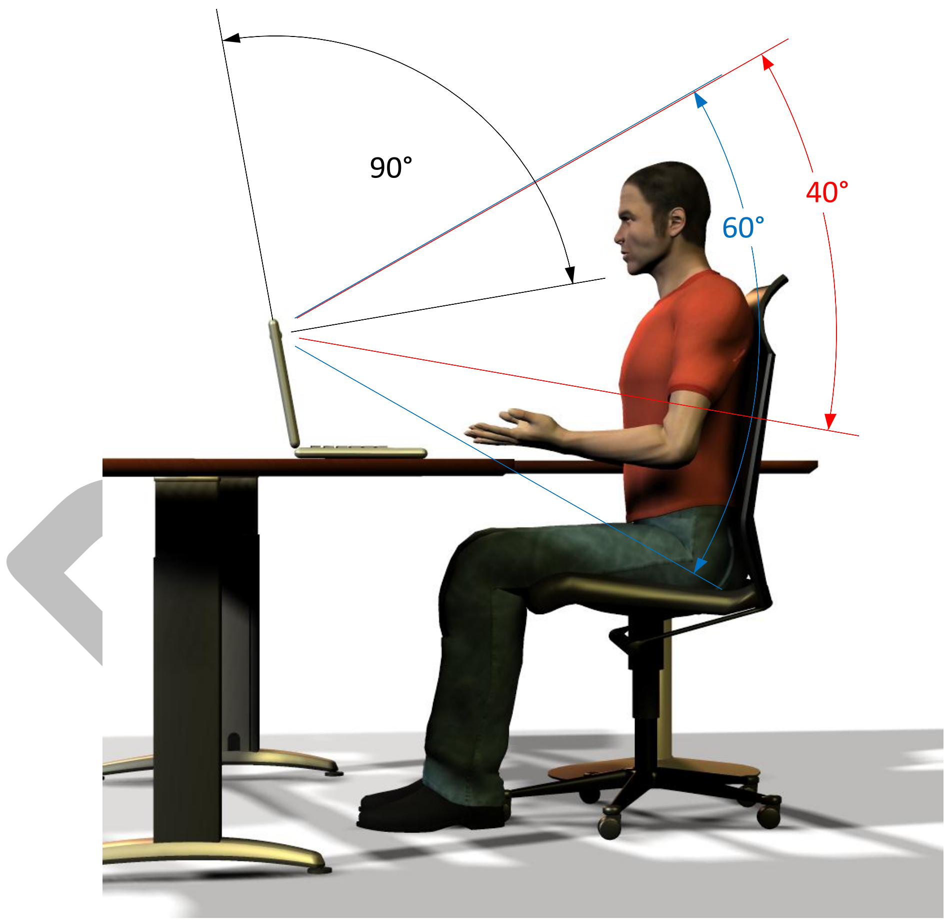

Figure 32: Vertical FOV for a notebook conferencing scenario

Figure 33: Left: 40° VFOV; Right: 60° VFOV

4.2.11.2 Requirements

	Basic/Standard	Premium
VFOV	≥ 35 deg	≥ 40 deg

Table 28: Field of view

4.2.11.3 Test setup

Lighting	Any
Test charts	NA
DUT position	Pointed at any test target at a distance D away
DUT settings	Default

Table 29: Field of view test setup

4.2.11.4 Test procedure

1. For each P1 resolution and max resolution:
    a. Measure the height of the target viewed (H) by the image (see Figure 34).
    b. Compute: $VFOV = 2\tan^{-1}\frac{H}{2D}$

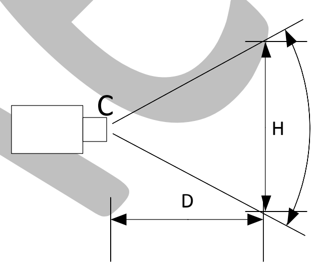

Figure 34: VFOV setup

4.2.12 P1: Depth of field

4.2.12.1 Purpose

Defines the range the camera with fixed focus, manual focus, or automatic focus should be able to focus.

Related standard: ISO 12233-2000.

4.2.12.2 Requirements

	Requirement
Depth of field	0.3 m to 1.5 m

Table 30: Depth of field

4.2.12.3 Test setup

Lighting	3500 K test lighting (Figure 52), 200 +/- 20 lux at target
Test charts	Slanted edge resolution chart (Figure 53)
DUT position	Pointing at test chart at a distance of 0.3 m, 1.5 m
DUT settings	Default If the DUT is manual focus, focus it on test chart.

Table 31: Depth of field test setup

4.2.12.4 Test procedure

1. For each P1 resolution and max frame rate:
    a. If the DUT is manual focus, focus it on a target at 0.5 m away for notebook scenarios, 0.7m away for desktop scenarios.
    b. Measure the MTF per Section 4.2.5.3 at a distance of 0.3 m.
    c. Measure the MTF per Section 4.2.5.3 at a distance of 1.5 m.
    d. Both 0.3 m and 1.5 m should pass the MTF criteria given in Table 17.

4.2.13 P1: Automatic exposure and gain

4.2.13.1 Purpose

Automatic exposure and gain control are needed to ensure the image has sufficient contrast and isn't saturated in typical light conditions.

4.2.13.2 Requirements

	Requirement
Supports AEC and AGC	Default enabled

Table 32: Video AEC and AGC

4.2.13.3 Test setup

Lighting	3500 K test lighting (Figure 52), 200 +/- 20 lux at target 3500 K test lighting (Figure 52), 50 +/- 5 lux at target
Test charts	ST-52
DUT position	Pointing at test chart at a distance of 0.5 m
DUT settings	Default

Table 33: Automatic exposure and gain test setup

4.2.13.4 Test procedure

1. Run LyncVidCap
2. In the lab test setup take an image of the ST-52 chart at 50 lux and a 200 lux
3. Analyze the step charts with Imatest and examine the CSV file to determine the median Y value for the black and white squares (zones 1 and 12). The difference between the white square median Y value and the black square median Y value must be less than 15% between images in step 2:

$$\frac{\max(|B_1 - B_2|, |W_1 - W_2|)}{255} < 0.15$$

4.2.14 P1: Geometric distortion

4.2.14.1 *Purpose*

Low geometric distortion makes images less distorted so that captured images more accurately represent the real scene.

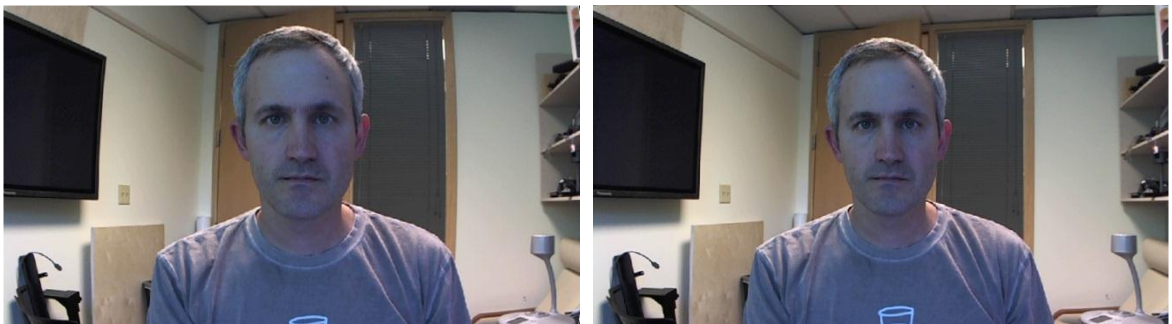

Figure 35: Left: Distortion=8.3%; Right: Distortion=3%

4.2.14.2 *Requirements*

	Basic	Standard	Premium
Absolute_Value(Geometric distortion)	≤ 9%	≤ 6%	≤ 3%

Table 34: Geometric distortion

4.2.14.3 *Test setup*

Lighting	3500 K test lighting (Figure 52), 200 +/- 20 lux
Test charts	Distortion grid (checkbox pattern)
DUT position	Pointing at test chart to fill the field of view.
DUT settings	Default

Table 35: Geometric distortion test setup

4.2.14.4 *Test procedure*

1. For each P1 resolution and max frame rate:
    a. Capture an image of the distortion grid.
    b. Run Imatest and select the Distortion module.
    c. Select the ROI (see Figure 36).
    d. Select “Plot intersection points” and “Checkerboard” in the “Distortion settings and options” dialog (see Figure 37).
    e. Compare absolute value of “SMIA TV Distortion” from the “Distortion Plot” (Figure 38) with above criteria.

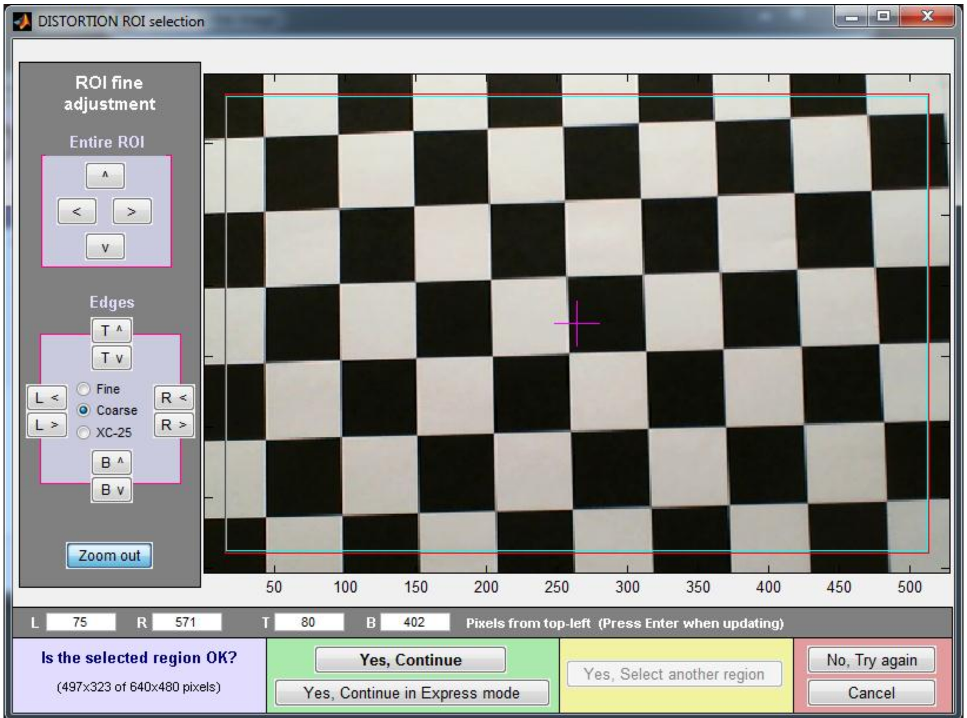

Figure 36: Imatest geometric distortion ROI

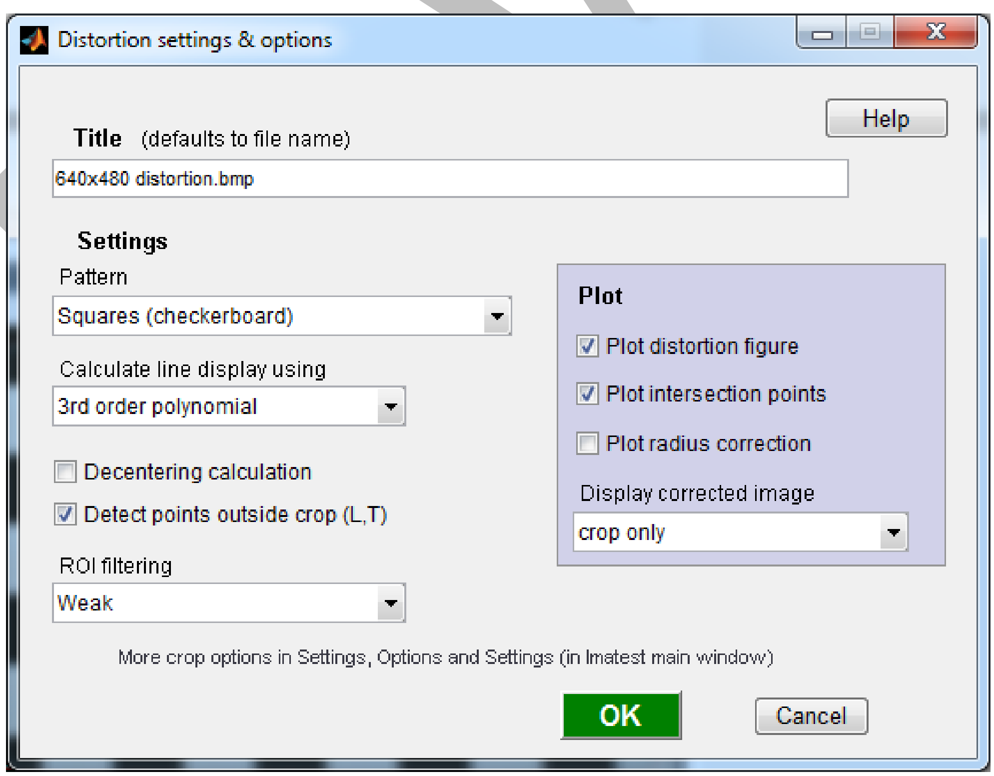

Figure 37: Imatest setup for geometric distortion

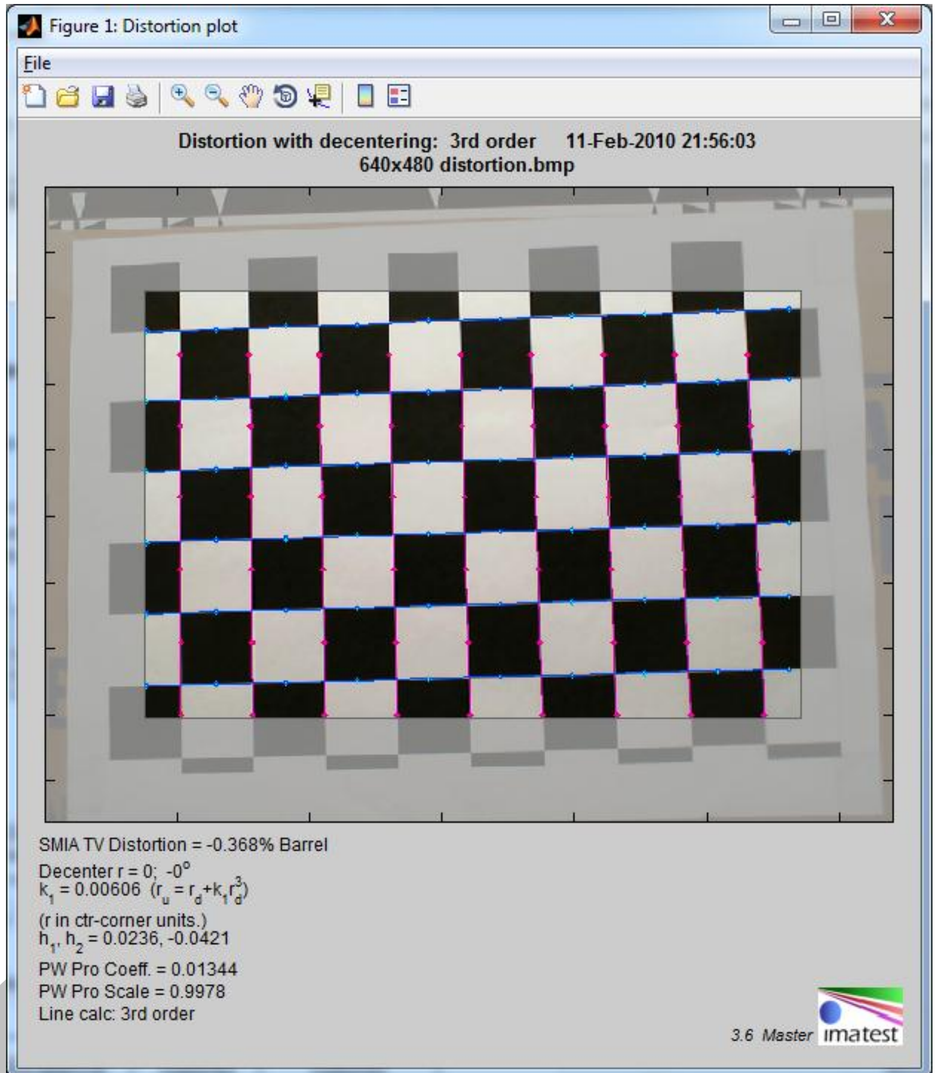

Figure 38: Geometric distortion results

4.2.15 P1: Pixel aspect ratio

4.2.15.1 Purpose

The correct pixel aspect ratio is important so that the captured images look normal and not stretched out horizontally or vertically. Note that this is particularly important for CIF which has a non-unity pixel aspect ratio. The nominal CIF aspect ratio is 0.92; the nominal non-CIF resolution aspect ratios are 1.0.

Figure 39: Left: Pixel aspect ratio=1 for CIF (incorrect); Right: Pixel aspect ratio=0.92 for CIF (correct)

4.2.15.2 Requirement

	Requirement
CIF	0.90 ≤ R ≤ 0.94
All other resolutions	0.98 ≤ R ≤ 1.02

Table 36: Pixel aspect ratio

4.2.15.3 Test setup

See Section 4.2.14.

4.2.15.4 Test procedure

1. Run the test in Section 4.2.14.
    a. Select "Plot intersection points" in Imatest.
2. Read off pixel aspect ratio, $\Delta x/\Delta y$ in the Intersection Plot (see Figure 40).

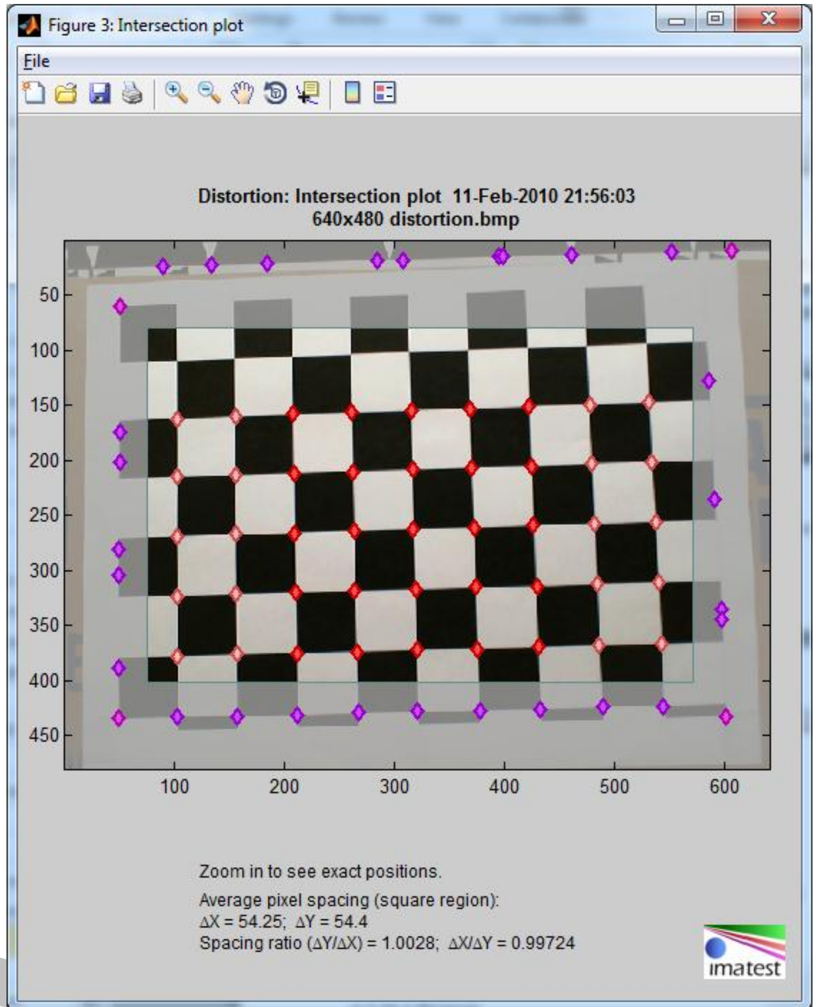

Figure 40: Pixel aspect ratio results

4.2.16 P1: Color accuracy and saturation

4.2.16.1 Purpose

Accurate colors and saturation are required to make images look natural under various lighting temperatures. Note the criteria for A (2856K) lighting is relaxed compared to 3500 K and Day to allow A lighting to still have a yellow tint. Figure 41 gives an example of good and bad color accuracy.

Figure 41: Left: Image with poor color accuracy (Mean $\Delta C_{00} = 15$, Max $\Delta C_{00} = 28$); Right: (Mean $\Delta C_{00} = 0.6$, Max $\Delta C_{00} = 1.7$);

4.2.16.2 Requirements

	Basic / Standard	Premium
Automatic white balancing	Supported	Supported
3500 K Day (6500 K)	Max $\Delta C_{00} \leq 15$ Mean $\Delta C_{00} \leq 10$	Max $\Delta C_{00} \leq 10$ Mean $\Delta C_{00} \leq 5$
A (2856 K)	Max $\Delta C_{00} \leq 20$ Mean $\Delta C_{00} \leq 15$	Max $\Delta C_{00} \leq 15$ Mean $\Delta C_{00} \leq 10$

Table 37: Color accuracy for different color temperatures

Lighting	Basic	Standard / Premium
50 lux	75% ≤ Sat ≤ 125%	85% ≤ Sat ≤ 115%
200 lux	90% ≤ Sat ≤ 140%	100% ≤ Sat ≤ 130%

Table 38: Color saturation

4.2.16.3 Test setup

Lighting	A, 3500 K, Day test lighting (Figure 52), 200 +/- 20 lux at target
Test charts	ColorChecker
DUT position	Pointing at test chart at a distance of 0.5 m
DUT settings	Default

Table 39: Color accuracy test setup

4.2.16.4 Test procedure

The first check is that the camera driver supports automatic white balance:

1. Run LyncVidCap.
2. For each P1 resolution and max frame rate:
    a. Select the P1 resolution and frame rate.
    b. Select Settings | Video Capture Filter… and examine the White Balance control. It should have "Auto" checkbox selected by default (selectable white balance isn't required).

The next test checks the color performance under different lighting temperatures.

1. For each P1 resolution and max frame rate:

a. Capture an image of the ColorChecker chart with lights 3500 K, A (2856 K), and Day (6500 K).

c. Run Imatest, select the Colorcheck module, and load a saved image.

d. Select the ROI for the ColorChecker image (see Figure 42).

e. Select the Delta C-00 option (see Figure 43).

f. Read the mean and maximum corrected ΔC_{00} result from the “a*b* D65 Color error” figure (see Figure 44) and compare with the above criteria.

g. Read the Saturation result from the “a*b* D65 Color error” figure (see Figure 44) and compare with the above criteria.

h. Repeat for all temperatures.

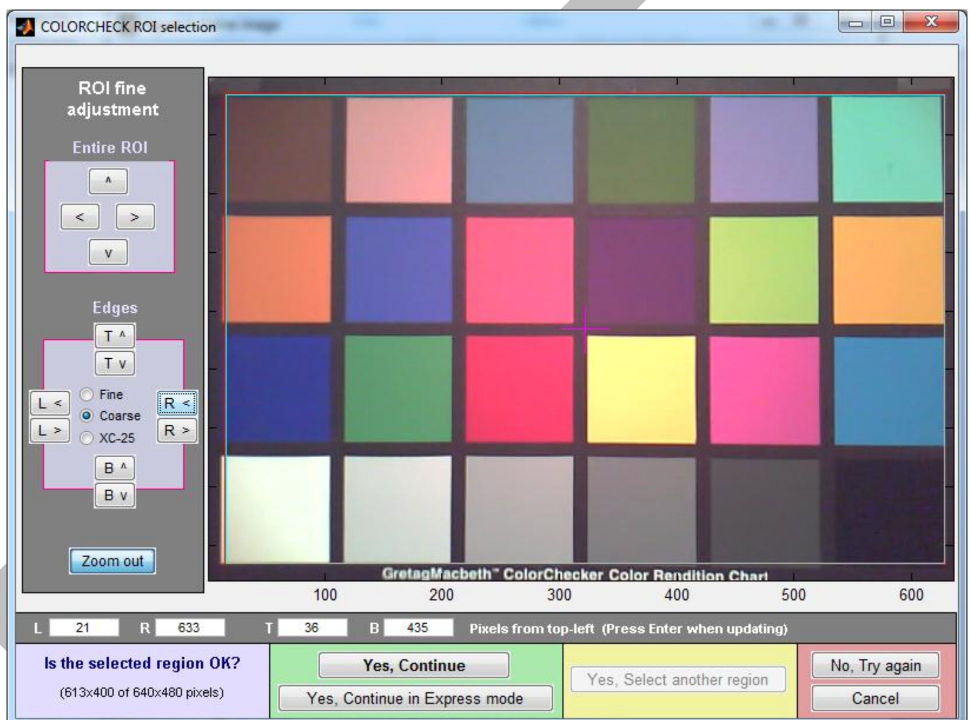

Figure 42: Color accuracy ROI setup

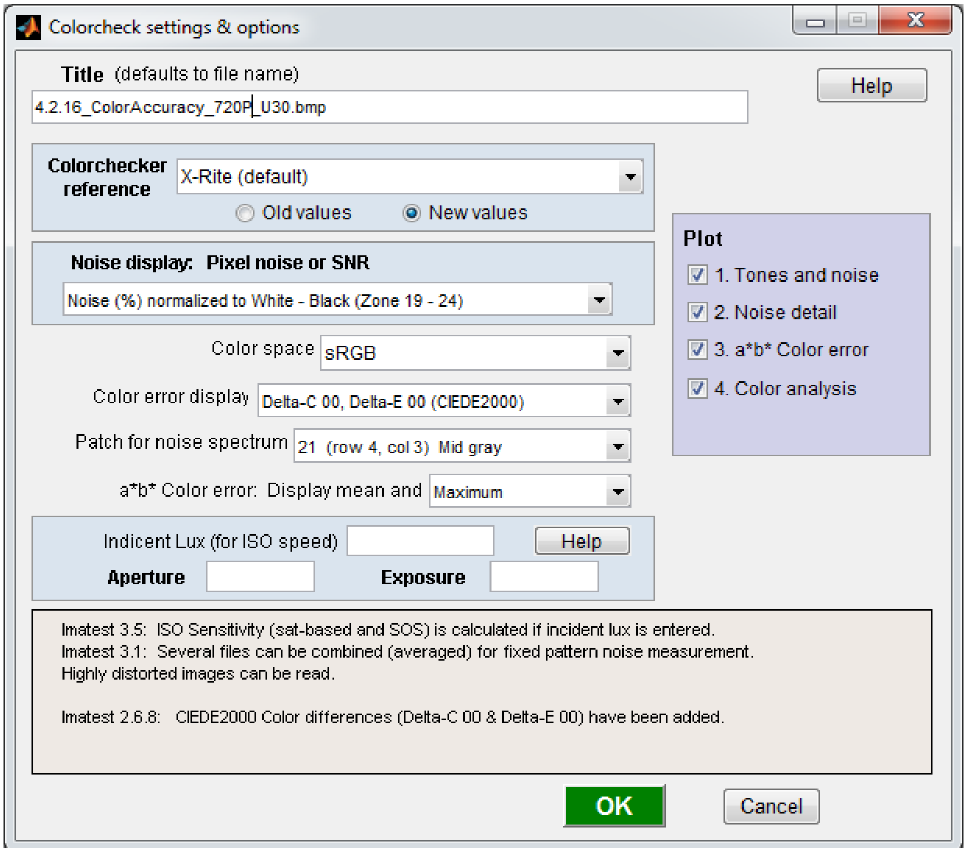

Figure 43: Color accuracy setup

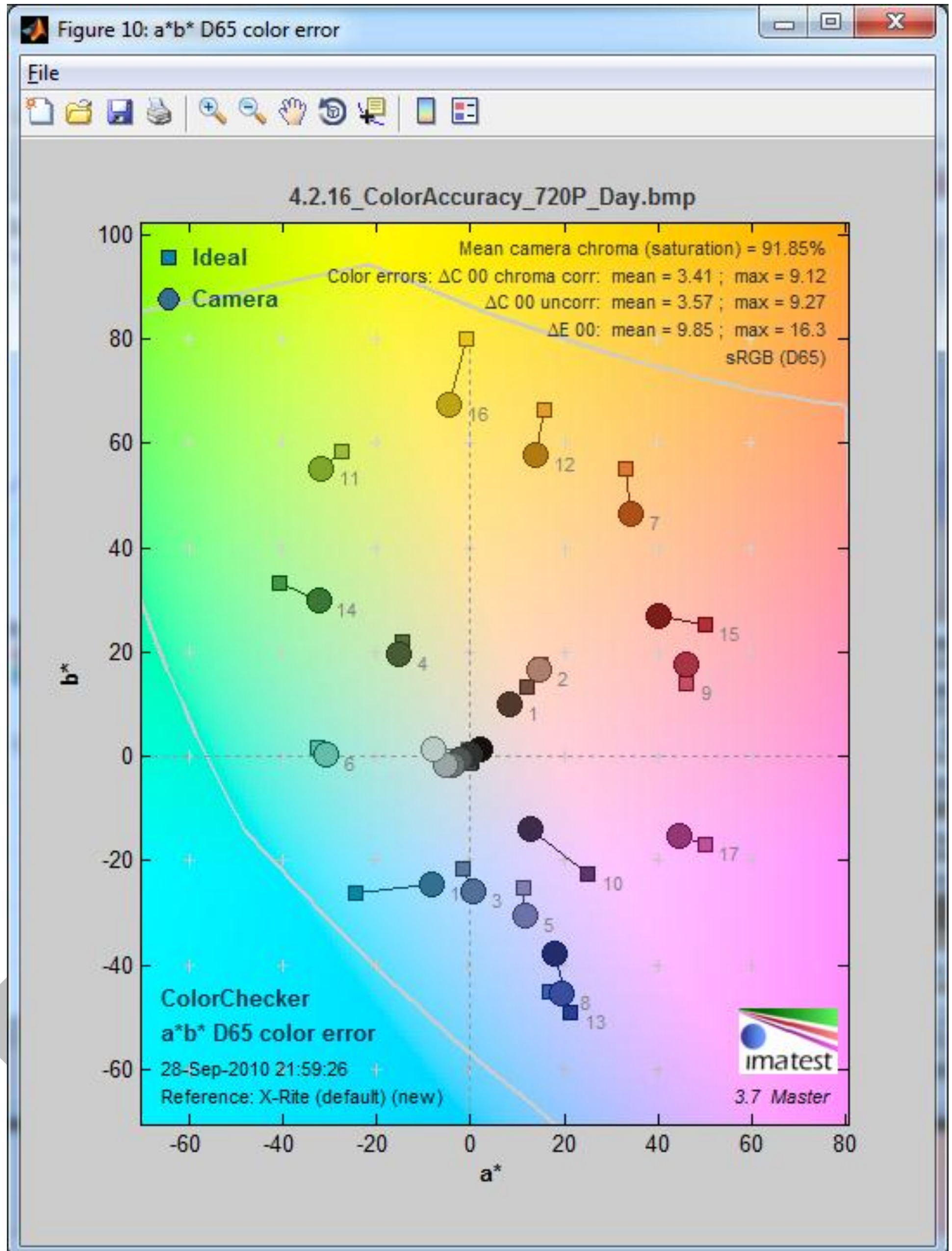

Figure 44: Color accuracy results

4.2.17 P1: Anti-flicker solution

4.2.17.1 Purpose

Imaging in 50 or 60 Hz lighting with the wrong exposure (powerline frequency) mode can result in flicker that significantly degrades SNR (> 8 dB in our tests). This is especially important for notebook computers that may travel between 50 and 60 Hz countries.

4.2.17.2 Requirements

The camera must include one of the following solutions to remove flickers due to 50 and 60 Hz lighting.

	Basic/Standard	Premium
Anti-flicker	Support 50 Hz or 60 Hz AEC modes	Automatically selects 50 Hz or 60 Hz AEC mode

Table 40: Anti-flicker solution

4.2.17.3 Test setup

See Section 4.2.8. Incandescent (A) lighting should be used.

4.2.17.4 Test procedure

The first test is to verify that the camera and driver support the anti-flicker functionality:

1. Run LyncVidCap.
2. Select Settings | Video Capture Filter… and examine the Powerline frequency control. If it supports a selectable 50 and 60 Hz frequency, then it passes the Standard criteria. If it has an "Auto" checkbox that is selectable (only OEM drivers can support a selectable checkbox) and default selected, or is hardcoded to automatic powerline frequency, then it passes the Premium criteria.

The next test compares SNR at different powerline frequencies. Tests need to be run for all P1 resolutions and for max frame rates. For Standard webcams.

1. Set the DUT powerline frequency to 50 Hz.
2. Use a 50 Hz light power source and measure the temporal SNR per Section 4.2.8.
3. Set the DUT powerline frequency to 60 Hz.
4. Use a 60 Hz light power source and measure the temporal SNR per Section 4.2.8.
5. Compare these 2 SNRs. They should be within 2 dB of each other to pass.
6. Inspect the video in step 2 and step 4 for powerline flicker. See Figure 45 for an example of the horizontal bands that move in the horizontal direction when the powerline frequency is not set correctly.

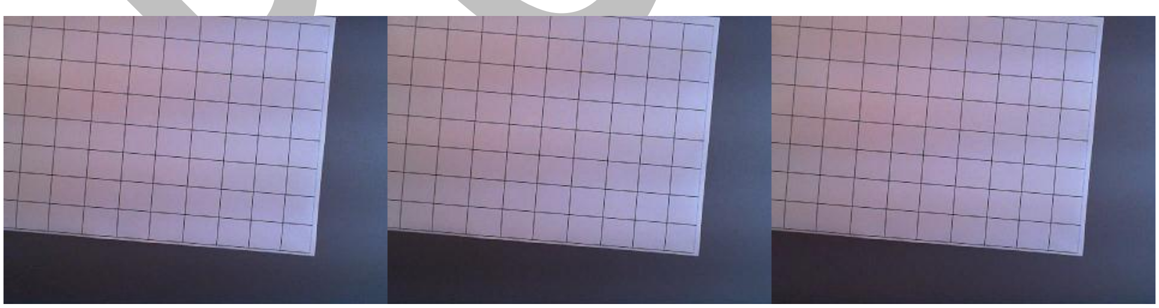

Figure 45: Video flicker example (3 consecutive images)

For Premium webcams the following will test for automatic anti-flicker. Note that the some webcams check for lighting frequency only on startup so the camera should be in the tested frequency and restarted for each step below.

1. Use a 50 Hz light power source and measure the temporal SNR per Section 4.2.8.

2. Use a 60 Hz light power source and measure the temporal SNR per Section 4.2.8.
3. Compare these 2 SNRs. They should be within 2 dB of each other to pass.
4. Inspect the video in step 2 and step 4 for powerline flicker. See Figure 45 for an example of the horizontal bands that move in the horizontal direction when the powerline frequency is not set correctly.

4.2.18 P1: Autofocus performance

4.2.18.1 Purpose

This requirement specifies autofocus performance and manual focus API support (also for cameras with autofocus). Most webcams with autofocus experience "focus swimming" and sometimes get stuck in an unfocused state. The typical desktop scenario doesn't need autofocus, as the camera's depth of field at the nominal distance of 0.5 m from the camera to user is sufficient. To minimize focus swimming, the autofocus performance is specified in a real-world test. To allow Lync to programmatically specify manual focus, the default manual focus performance is specified.

4.2.18.2 Requirements

1. Autofocus performance: Images must be focused 99% of the time over 5 minutes in a typical use-case scenario (see test procedure).
2. Manual-focus performance: The default manual focus target must be 0.5 m. This allows manual focus to be used to eliminate focus swimming and ensures that users are in focus in most desktop and notebook scenarios. The default manual focus MTF30 must be with 15% relative error to the autofocus MTF30.

4.2.18.3 Test setup

Lighting	300 +/- 30 lux office lighting (see Section 4.5.2)
Test charts	NA
DUT position	In typical usage position, pointing at user Lighting should be overhead lighting only (no windows with sunlight). The lighting room should have neutral colors and the user wear neutral color, low frequency (i.e., no stripes) clothing.
DUT settings	Default

Table 41: Focus test setup (autofocus)

Lighting	3500 K test lighting (Figure 52), 200 +/- 20 lux at target
Test charts	Slanted edge test chart
DUT position	Pointing at test chart at a distance of 0.5 m
DUT settings	Default

Table 42: Focus test setup (manual focus)

4.2.18.4 Test procedure

4.2.18.4.1 Autofocus performance

1. For each P1 resolution and max frame rate:

a. Capture 5 minutes of video with LyncVidCap of the user simulating a typical desktop video conference, including back and forth motion and moving forward and away from the monitor.
b. Examine the captured video file using VirtualDub or a similar tool that allows stepping frame-by-frame and estimate the % of images that are not focused.
c. Compare results with requirements.

4.2.18.4.2 Manual-focus performance

1. Set up the webcam 500 mm from the slanted edge test chart.
2. For each P1 resolution and max frame rate:
    a. Run LyncVidCap.
    b. Enable autofocus using the Camera Control dialog box (see Figure 46.)
    c. Capture an image.
    d. Disable autofocus.
    e. Adjust the focus so that the image is fuzzy.
    f. Press the Default button (see Figure 46).
    g. Capture an image.
    h. Run Imatest and compute the vertical MTF30 for images (c) and (f). See Section 4.2.5.
    i. MTF30 must be within 15% relative error.

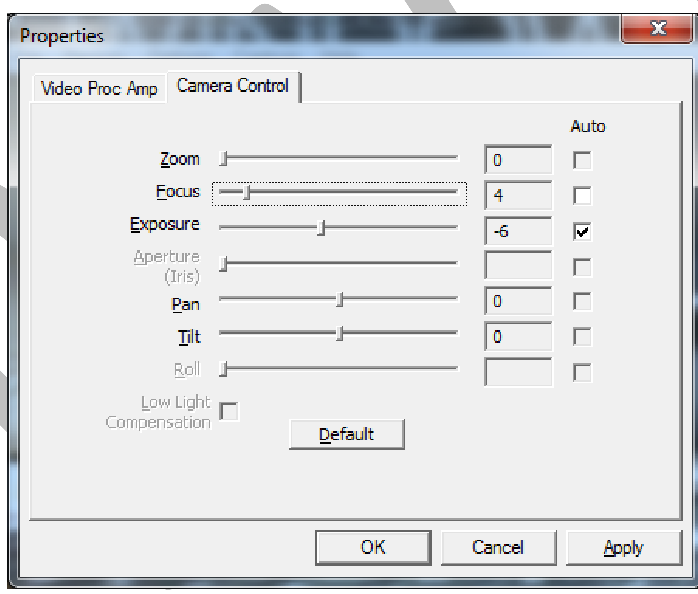

Figure 46: Camera Control dialog box for setting focus mode

4.2.19 P1: Audio/video synchronization

4.2.19.1 Purpose

Audio video synchronization is required for lip synchronization. ITU-R BT.1359-1 gives recommended limits on audio video synchronization. Audio video synchronization can fail if the webcam uses excessive frame buffers for processing video with low latency audio, or has significant delay with audio processing with low latency video.

Related standard: ITUR BT.1359-1, ITU-T J.100.

4.2.19.2 Requirements

The requirements are given in Table 43. This is a capture+render specification and is adjusted to account for that. The actual A/V synchronization coming from the camera should be much tighter.

	Basic/Standard	**Premium**
A/V synchronization	Audio leads video ≤ 45 ms Audio lags video ≤ 125 ms	Audio leads video ≤ 35 ms Audio lags video ≤ 115 ms

Table 43: Audio/video synchronization

4.2.19.3 Test setup

Lighting	300 +/- 30 lux office lighting (see Section 4.5.2)
Test charts	NA
DUT position	In typical usage position, pointing at user holding clapper board
DUT settings	Default

Table 44: Focus test setup (autofocus)

4.2.19.4 Test procedure

1. For each P1 resolution and max frame rate:
    a. Run LyncVidCap and select Settings | Measure AV Sync
    b. Point camera at AV sync test hardware (see Figure 47).
    c. Focus camera
    d. Read off the AV Sync in the LyncVidCap window.

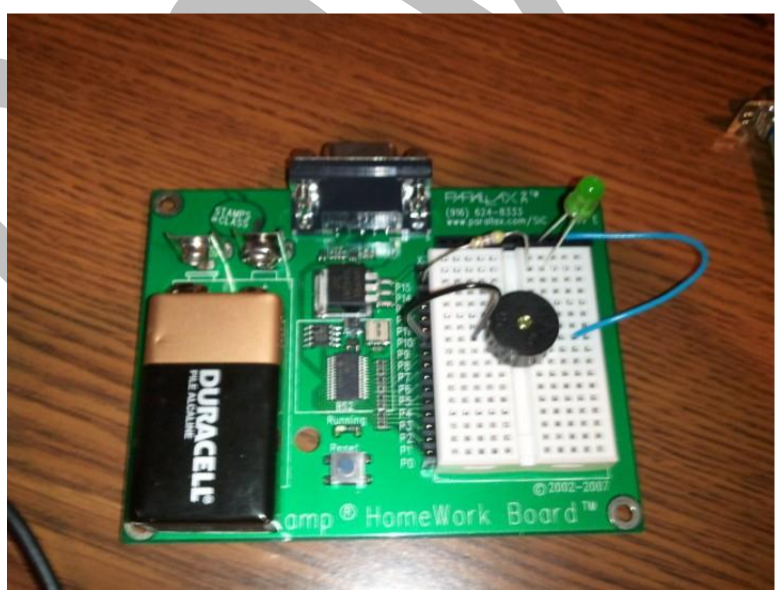

Figure 47: AV sync test hardware

4.2.20 P1: Lower resolution images must give higher SNR

4.2.20.1 Purpose

In lower light scenarios better image quality (higher SNR) can be obtained by reducing the frame rate from 30 FPS (but still maintaining 15 FPS). Further SNR improvements can be achieved by lowering the resolution, which effectively increases the pixel size. By reducing the resolution by 50% in each dimension the SNR theoretically can be increased by 6 dB if all of the pixels are used in the scaled image. The actual SNR improvement is less due to noise reduction (spatial filtering) in the ISP. Figure 48 shows a 720p image in 20 lux resized to 240p using nearest neighbor and antialiasing + bicubic interpolation. Nearest neighbor interpolation does not increase the image SNR and therefore gives no improved PSNR with the codec.

Figure 48: Top: Image resized using nearest neighbor interpolation; Bottom: image resized using antialiasing + bicubic interpolation

4.2.20.2 Requirements

	Standard/Premium
SNR improvement	>= 2 dB for 50% resolution reduction

Table 45: SNR improvement requirements for lower resolution images

4.2.20.3 Test setup

Lighting	3500 K test lighting (Figure 52), 50 +/- 5 lux at target
Test charts	ST-52
DUT position	Pointing at test chart at a distance of 0.5 m Ensure minimal keystoning (perspective distortion) with chart
DUT settings	Default

Table 46: Lower resolution SNR test setup

4.2.20.4 Test procedure

1. For max P1 resolution and max frame rate:
    a. Capture an image.
    b. Run Imatest and select the Stepchart analysis module.
    c. Adjust the ROI and select “Noise in pixels (max 255)” and “Pixel SNR (dB) (20*log10(S/N))” (see Figure 18).
    d. Do fine adjustments for the ST-52 ROI (see Figure 19).
    e. Read the spatial,l SNR (density 0.7) in “Stepchart noise detail” figure (see Figure 20). It is called “Dnom=0.7” and is the last (4th) value in a list, highlighted in red. Enter this value in the Excel workbook template and compare the results with the criterion.
2. Repeat step 1 for nearest resolution 50% or less (e.g., 360p if 720p is used in step 1)
3. Compare SNR of step 1 and 2 with criteria in Table 45.

4.2.21 P1: Veiling glare

4.2.21.1 Purpose

Cameras without lens hoods or sufficient anti-reflective coating will typically have a significantly lower dynamic range in scenarios with overhead lighting. Veiling glare is a standard measure of how stray light impacts image quality, especially dynamic range.

Related standards: ISO 9358

4.2.21.2 Requirements

	Basic	Standard	Premium
Veiling glare	<= 1%	<= 0.5%	<= 0.1%

Table 47: Veiling glare requirements

4.2.21.3 Test setup

Lighting	Integrating sphere compliant to ISO 9358
Test charts	NA
DUT position	Pointing and adjacent to integrating sphere (see Figure 49)
DUT settings	Default

Table 48: Veiling glare test setup

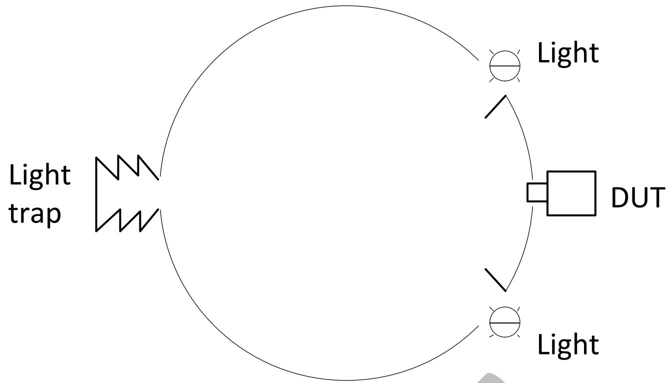

Figure 49: Integrating sphere and DUT setup (see ISO 9358)

4.2.21.4 Test procedure

1. For the max P1 resolution and max frame rate, capture a test image
2. Using PhotoShop and a 5x5 window measure the black level and surrounding white level of the captured image (e.g., see Figure 51) and enter these values into the Excel worksheet
3. Compare computed Veiling Glare values to the criteria in Table 47

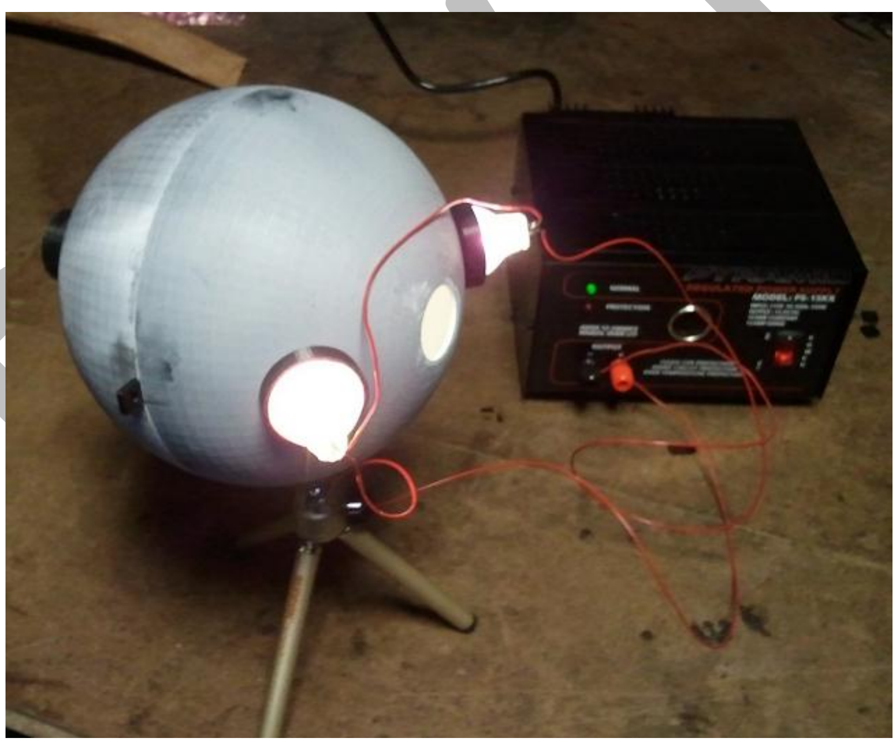

Figure 50: Integrating sphere with light trap (see ISO 9358)

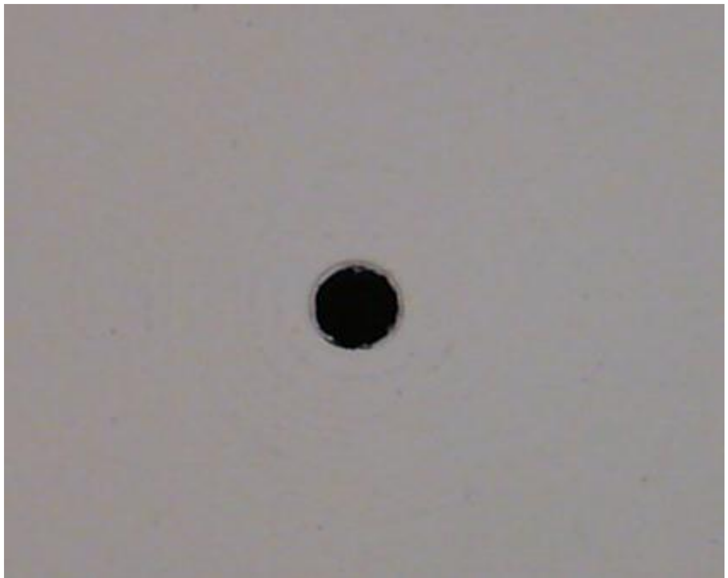

Figure 51: Sample veiling glare image

4.3 Audio

Webcams with built- in microphones must meet the requirements given in the *Microsoft Lync Devices Audio Specification*. Only send path handsfree audio is required from this specification. All tests must be run using both the Windows UAC driver and any supplied audio driver.

4.4 Other

4.4.1 P1: Usage indicator

4.4.1.1 Purpose

This requirement lets the user know when the camera is on and imaging the user or off and not imaging the user.

4.4.1.2 Requirements

	Requirement
Usage indicator	Light on when capturing video Light can be on when capturing audio (optional) Usage light off otherwise

Table 49: Usage indicator

4.4.1.3 Test setup

Lighting	300 +/- 30 lux office lighting (see Section 4.5.2)
Test charts	NA
DUT position	In normal usage position pointing at the user
DUT settings	Default

Table 50: Usage indicator test setup

4.4.1.4 Test procedure

1. The usage indicator light should be clearly visible (on/off) from a typical usage position.
2. With DUT plugged in but not in use, examine usage indicator; it should be off.
3. For each P1 resolution and max frame rate:
    a. Run LyncVidCap and render the capture source. DUT usage indicator should be on.

4.5 Video test setup

4.5.1 Test components

The video test setup components include:

- The test room setup shown in Figure 52. Using two 45° lights help provide glare-free images and approximately uniform lighting. The lights need to support incandescent (A: 2856 K), florescent (3500 K[9]), and Day (6500 K[10]). Multiple lights[11] or a filter should be used to adjust the luminance on the target to 50 and 200 lux as measured with a calibrated light meter at the target. The uniformity across the target must be <10%. The test room color should be matte black using either paint or cloth to minimize reflections and improve test accuracy. The camera should only image an 18% neutral gray background[12] (excluding the test charts).
- Imatest Master v 3.8 or newer
- Slanted edge resolution test chart created with Imatest (10:1 contrast ratio). See Figure 53. This chart should be A3 size, 720 DPI, and rotated 5° with respect to the horizon. A default gamma=2.2 should be used, and a Chart lightness=Light or Mid-light is recommended to avoid saturation.
- x-rite ColorChecker Classic color chart. See Figure 55.
- ISO-14524 contrast chart (ST-52 160:1 contrast ratio). See Figure 54.
- 50 and 60 Hz power source
    - For example, Xantrex Sine Wave Inverter 1000i
- GraphEdit, part of DirectX SDK.

---

[9] Sylvania Octron 3500 K FO17/735/ECO, 75 CRI
[10] GRETAGMACBETH F20T12/65 D65
[11] The Microsoft Lync video lab uses a Kino Flo 4 Bank One 2' Light System
[12] The Microsoft Lync Lab uses the following paint:

L*a*b*: 49.48, -0.03, -0.32
RGB: 117.3, 117.7, 118.1
Color Temperature: 6565.7°K

Behr Ultra Deep Base Matte	1 Gallon	
Tint	Oz	1/384 oz
B	3	208
C	0	176
F	0	64
KX	7	32

- LyncVidCap, part of the Lync Video Capture tools distribution.
- Integrating sphere for measuring uniformity
    - For example SphereOptics
    - Temperature 3000 K to 3500 K
    - Alternative uniform light source can be used; should be uniform with RI≥90%.
- Distortion chart printed with Test Charts module in Imatest
    - 720 dpi, A3 or US Tabloid size, checkerboard, divisions=10. See Figure 56.
- Calibrated light meter
    - For example, BK Precision 615
- Test PCs that are running Windows XP SP2, Vista SP1, Windows 7
    - 1.8 GHz dual core
    - 2 GHz quad core
    - Video display adapter that supports VMR7 or VMR9 and video acceleration (DirectDraw BitBlt) for YV12 and RGB24/RGB32. Most recent ATI and NVidia cards support this.
- ISO 9358 compliant integrating sphere for measuring veiling glare
    - See "A low-cost method to measure veiling glare" by Ross Cutler for a low cost (<$100) test setup shown in Figure 50
- Parallax BASIC Stamp Board
    - Configured as shown in Figure 47
    - Loaded with code in Table 51

```
DO
    HIGH 14
    FREQOUT 9,167,3000
    LOW 14
    PAUSE 333
LOOP
```

Table 51: AV sync code for BASIC Stamp

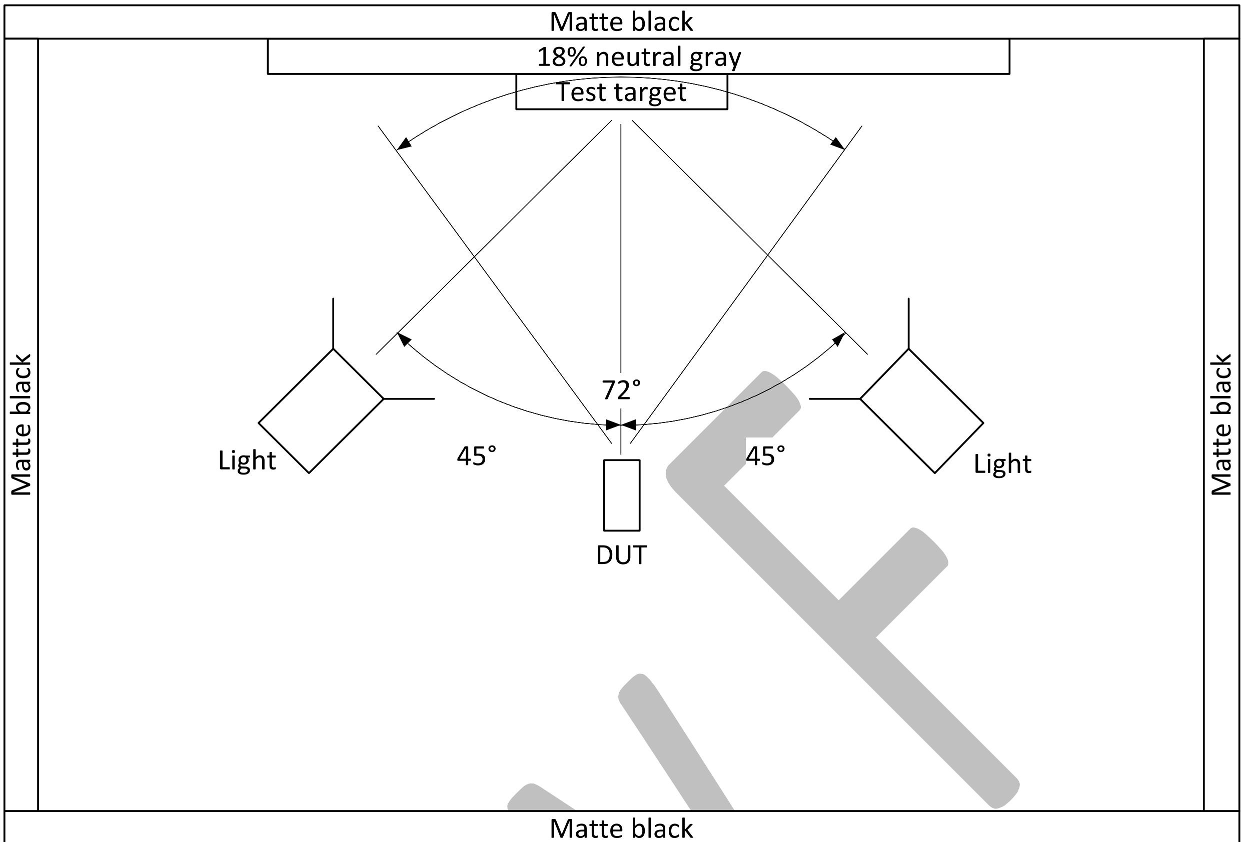

Figure 52: DUT test configuration

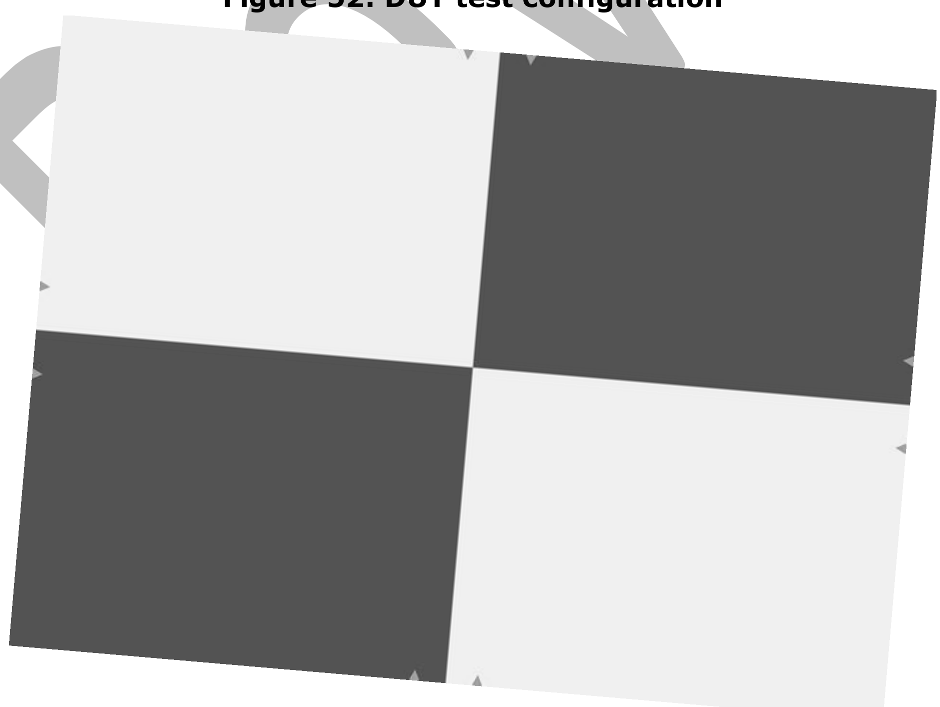

Figure 53: Slanted edge resolution chart (created with Imatest)

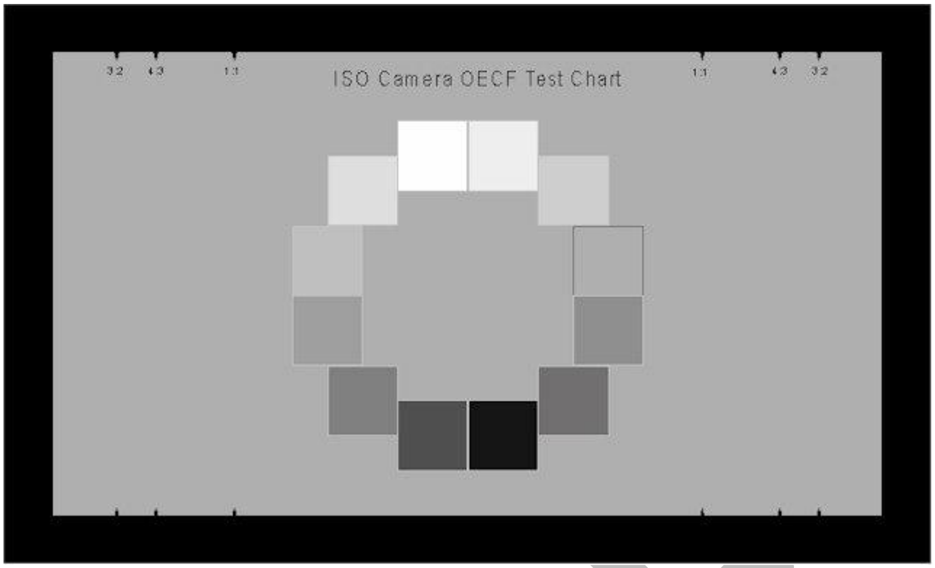

Figure 54: ISO-14524 contrast chart (ST-52)

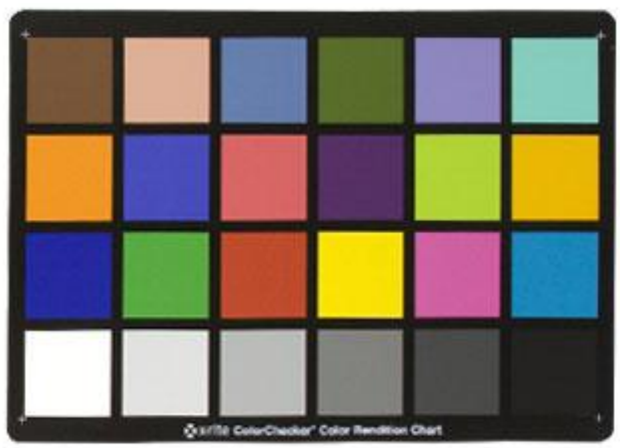

Figure 55: ColorChecker chart

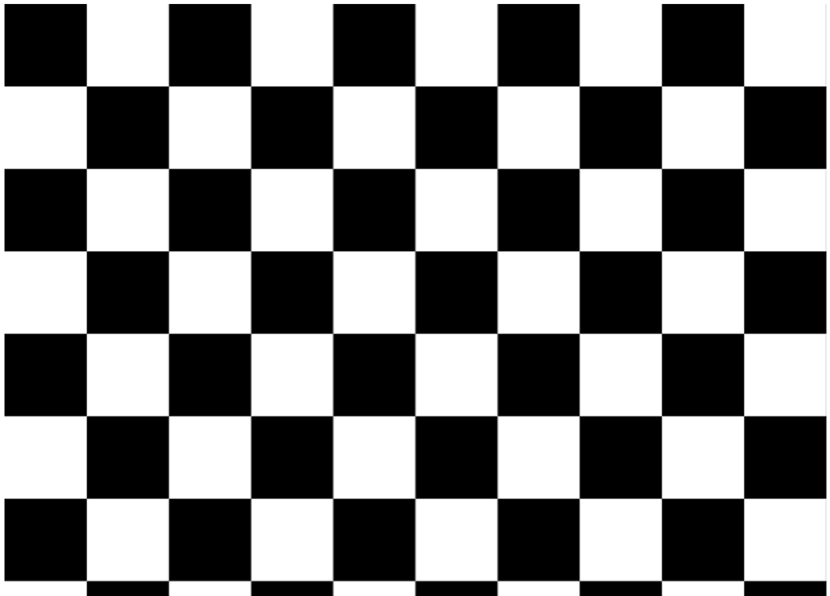

Figure 56: Distortion chart (created with Imatest)

4.5.2 Room light measurements

Several tests require ambient room lighting. The nominal office lighting used for these tests is 300 lux, which is derived from these standards:

1. ANSI RP-1-04 American National Standard Practice for Office Lighting: Office lighting for performing common visual tasks with high contrast objects is 300 lux, measured on the working horizontal surface (for example, desk) as shown in Figure 57.
2. OSHA 1926.56 Illumination: Offices are 30 foot-candles (330 lux).

For lower light office scenarios, 150 lux is used.

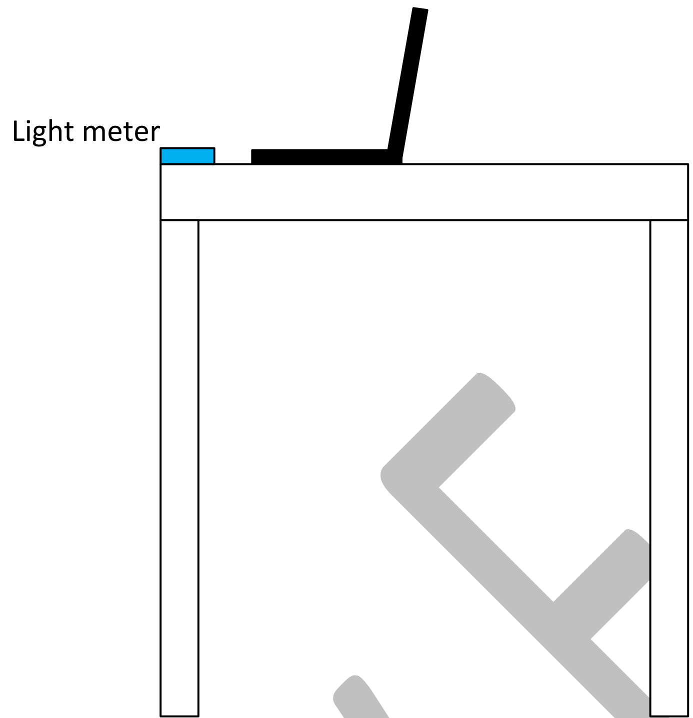

Figure 57: Light meter placement example for notebook computer ambient light

4.6 DUT preparation

The DUT lens or cover glass should be cleaned using a microfiber cloth before testing. Fingerprints or other smudges on the lens or cover glass will significantly degrade many of the test metrics.

5.0 Appendix

5.1 M420 FourCC format

Most webcams don't have a frame buffer to output the planar I420, so a new packed I420 format, M420, is proposed. The motivation for using this format is to reduce the USB bandwidth compared to YUY2 by using 12-bit instead of 16-bit pixels (on average), which increases the number of possible HD resolutions at 30 FPS on USB 2.0. There should be no loss in quality for applications that require I420 (for example, video conferencing using H.264 or RTVideo), and M420 is easier/faster to convert to I420 than YUY2. The byte order format is selected to make M420 to I420 a memory copy (no filtering is required).

The YUV sampling is shown in Table 52, a YUV pixel image of height H and width W is shown in Table 53, Table 54, and Table 55. Each 2x2 YUV pixel blocks are ordered in row major order. The byte order for an image is:

Y(1,1), Y(2,1), Y(3,1), Y(4,1), …, Y(W-1,1) , Y(W,1)
Y(1,2), Y(2,2), Y(3,2), Y(4,2), …, Y(W-1,2) , Y(W,1)
U(1,1), V(1,1), U(2,1), V(2,1), …, U(W/2,1), V(W/2,1)
…

Y(1,H-1), Y(2,H-1), Y(3,H-1), Y(4,H-1), …, Y(W-1,H-1) , Y(W,H-1)
Y(1,H), Y(2,H), Y(3,H), Y(4,H), …, Y(W-1,H) , Y(W,H)
U(1,H/2), V(1,H/2), U(2,H/2), V(2,H/2), …, U(W/2,H/2), V(W/2,H/2)

	Horizontal	Vertical
Y Sample Period	1	1
V Sample Period	2	2
U Sample Period	2	2

Table 52: M420 YUV sampling

Y(1,1)	Y(2,1)		Y(W-1,1)	Y(W,1)
Y(1,2)	Y(2,2)		Y(W-1,2)	Y(W,2)
Y(1,H-1)	Y(2,H-1)		Y(W-1,H-1)	Y(W,H-1)
Y(1,H)	Y(2,H)		Y(W-1,H)	Y(W,H)

Table 53: M420 YUV Y format

U(1,1)		U(W/2,1)
U(1,H/2)		U(W/2,H/2)

Table 54: M420 YUV U format

V(1,1)		V(W/2,1)
V(1,H/2)		V(W/2,H/2)

Table 55: M420 YUV V format

M420 uses the YUV 420 color alignment scheme used in MPEG-2. In this scheme the chrominance samples are vertically centered between the luminance samples but horizontally aligned with the luminance samples in the frame as shown in Figure 33.

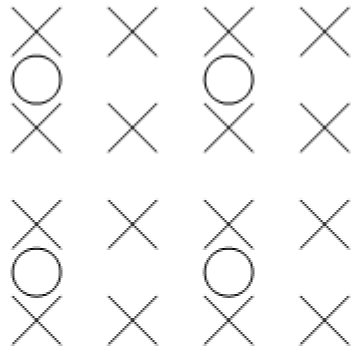

Figure 58: Luminance (X) and chrominance (O) alignment in M420

The M420 GUID is defined below:

```
// {3032344D-0000-0010-8000-00AA00389B71}
DEFINE_GUID(M420,
0x3032344D, 0x0000, 0x0010, 0x80, 0x00, 0x00, 0xAA, 0x00, 0x38, 0x9B, 0x71);
```

5.2 Face detector interface

The following interface allows Lync to interact with webcams that include face detector in their drivers. The IKsPropertySet::FACE_DETECTOR GUID is defined below:

```
// {B292AACE-1F6B-4DB7-931F-1D012FB8441B}
DEFINE_GUID(FACE_DETECTOR,
0xb292aace, 0x1f6b, 0x4db7, 0x93, 0x1f, 0x1d, 0x1, 0x2f, 0xb8, 0x44, 0x1b);
```

The IKsPropertySet::FACE_DETECTOR property returns a structure of the following format:

```
#define MAX_FACES 16

struct FaceDetectorResults {
        USHORT numFaces;
        Faces faces[MAX_FACES];
        REFERENCE_TIME detectionTime;
};

struct Faces {
        FLOAT likelihood;        // 0-1 likelihood that the RECT is a face
        RECT faceRect;
}
```

To query if the webcam driver supports face detection control:

```
#define FACE_DETECTOR_CONTROL 0
#define FACE_DETECTOR_RESULTS 1
```

```
#define FACE_DETECTOR_FREQUENCY 2
IKsPropertySet *propertySet = …
HRESULT hresult;
ULONG supported;
hresult = propertySet ->QuerySupported(FACE_DETECTOR,  FACE_DETECTOR_CONTROL, 
&supported);
```

To enable the face detector:

```
#define FACE_DETECTOR_DISABLE 0
#define FACE_DETECTOR_ENABLE 1

IKsPropertySet *propertySet = …
FaceDetectorResults results;
HRESULT hresult;
ULONG setProp = FACE_DETECTOR_ENABLE;
hresult = propertySet->Set(FACE_DETECTOR, FACE_DETECTOR_CONTROL, 0, 0, &setProp, 
sizeof(setProp));
```

To get the latest face detect results:

```
IKsPropertySet *propertySet = …
FaceDetectorResults results;
HRESULT hresult;
ULONG bytesReturned;
hresult = propertySet->Get(FACE_DETECTOR, FACE_DETECTOR_RESULTS, 0, 0, &results, 
sizeof(results), &bytesReturned);
```

To set the requirement frequency of face detection:

```
IKsPropertySet *propertySet = …
FaceDetectorResults results;
HRESULT hresult;
FLOAT32 frequency = 1;   // Hz
hresult = propertySet->Set(FACE_DETECTOR, FACE_DETECTOR_FREQUENCY, 0, 0, & frequency, 
sizeof(frequency));
```

5.3 Noise reduction interface

The following interface allows Lync to enable/disable noise reduction with for webcams that include noise reduction in their drivers. The IKsPropertySet:: NOISE_REDUCTION GUID is defined below:

```
// {E1599126-C0A9-4516-8D96-D109F1C23610}
DEFINE_GUID(NOISE_REDUCTION, 
0xe1599126, 0xc0a9, 0x4516, 0x8d, 0x96, 0xd1, 0x9, 0xf1, 0xc2, 0x36, 0x10);
```

The IKsPropertySet::NOISE_REDUCTION property is used in the following ways.

```
#define NOISE_REDUCTION_ENABLE 0
#define NOISE_REDUCTION_DISABLE 1
```

To query if the webcam driver supports noise reduction:

```
IKsPropertySet *propertySet = …
HRESULT hresult;
ULONG supported;
hresult = propertySet ->QuerySupported(NOISE_REDUCTION,  0, &supported);
```

To enable the noise reduction of the webcam driver:

```
IKsPropertySet *propertySet = …
HRESULT hresult;
ULONG enable= NOISE_REDUCTION_ENABLE;
hresult = propertySet -> Set(NOISE_REDUCTION, 0, 0, 0, & enable, sizeof(enable));
```

To disable the noise reduction webcam driver:

```
IKsPropertySet *propertySet = …
HRESULT hresult;
ULONG enable= NOISE_REDUCTION_DISABLE;
hresult = propertySet -> Set(NOISE_REDUCTION, 0, 0, 0, & enable, sizeof(enable));
```

5.4 Camera location interface

The following interface allows Lync to query the webcam location and orientation with respect to the monitor. The IKsPropertySet::CAMERA_LOCATION GUID is defined below:

```
// {E2F79997-A8AB-4A65-B824-C01CF3740A5F}
DEFINE_GUID(CAMERA_LOCATION,
0xe2f79997, 0xa8ab, 0x4a65, 0xb8, 0x24, 0xc0, 0x1c, 0xf3, 0x74, 0xa, 0x5f);
```

The IKsPropertySet::CAMERA_LOCATION property is used in the following ways. See Figure 59 for the coordinate system used in the camera locations.

```
#define MAX_CAMERAS 16
#define CAMERA_DIRECTION_FRONT_FACING 1
#define CAMERA_DIRECTION_REAR_FACING 2
#define CAMERA_ORIENTATION_PORTRAIT 1
#define CAMERA_ORIENTATION_LANDSCAPE 2
```

```
struct CAMERA_LOCATION_S {
    USHORT num_webcams;
    USHORT monitor_width;                    // in mm
```

```
    USHORT monitor_height;                        // in mm
    SHORT camera_x[MAX_CAMERAS];                  // in mm
    SHORT camera_y[MAX_CAMERAS];                  // in mm
    USHORT camera_direction[MAX_CAMERAS];         // front or rear facing
    USHORT camera_orientation[MAX_CAMERAS];       // portrait or landscape
};
```

To query if the display supports camera location:

```
    IKsPropertySet *propertySet = …
    HRESULT hresult;
    ULONG supported;
    hresult = propertySet ->QuerySupported(CAMERA_LOCATION,  0, &supported);
```

To query the camera locations:

```
    IKsPropertySet *propertySet = …
    HRESULT hresult;
    CAMERA_LOCATION_S camera_location;
    hresult = propertySet -> Get(CAMERA_LOCATION, 0, 0, 0, & camera_location,
    sizeof(camera_location));
```

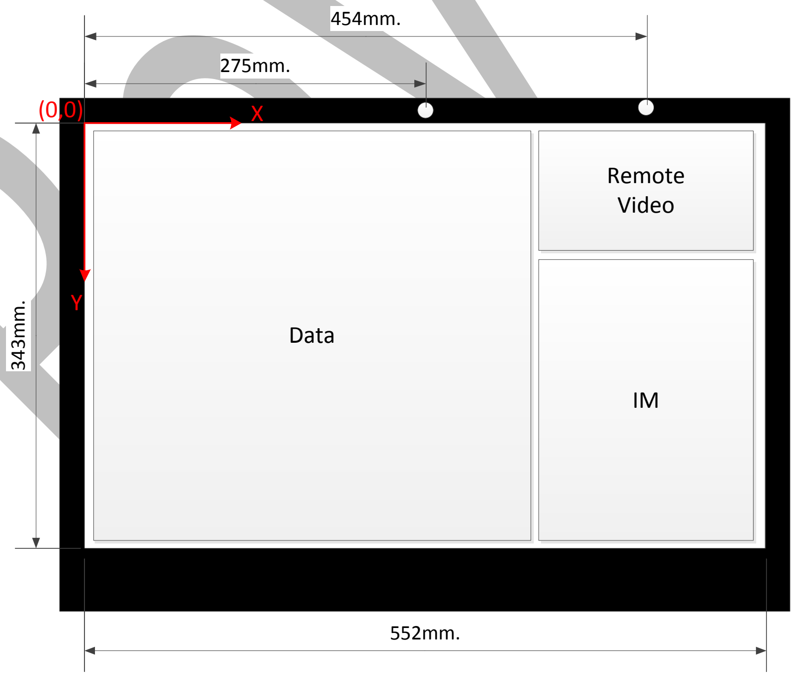

Figure 59: Coordinate system for defining camera locations and example for 2 camera desktop monitor

5.5 Conference room camera criteria

This section gives the criteria for webcams used in conference rooms for room system scenarios (as opposed to personal desktop scenarios). Figure 60 shows a typical small sized conference room with a 10x5' table. Table 56 gives the resolution for imaging with a 720p and 1080p camera for 6' and 10' tables. Figure 61 to Figure 64 show facial resolutions from 20 to 50 pixels across the face. About 40 pixels across the face are required to give good facial expression recognition.

Table 57 gives the criteria for conference room cameras which differ from the desktop scenario criteria in Section 4.2. These criteria will be enforced for devices that are intended to be used in conference rooms for room system scenarios.

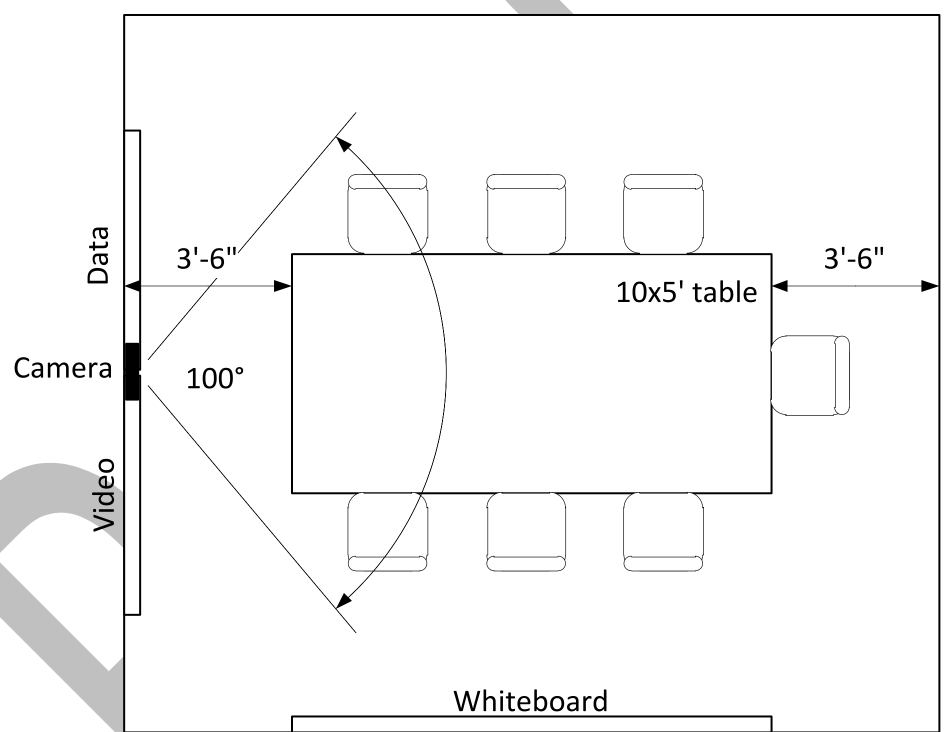

Figure 60: Small conference room

HFOV (deg)	100	100
Horizontal resolution (pixels)	1280	1920
Horizontal resolution (pixels/deg)	12.8	19.2
Head width (feet)	0.5	0.5
Table length (feet)	6.0	10.0
Head distance (feet)	10.0	14.0
Head width (deg)	2.9	2.0
Pixels across head	36.6	39.3

Table 56: Pixels across the head for different conference room sizes and 720p, 1080p cameras

Horizontal FOV	>= 100^{o}
Table length <= 6’	720p required
Table length <= 10’	1080p required
Depth of field	0.5m to 4m

Table 57: Conference room camera criteria

Figure 61: 20 pixels across the head (anger, fear, surprise, sadness, joy, disgust)

Figure 62: 30 pixels across the head (anger, fear, surprise, sadness, joy, disgust)

Figure 63: 40 pixels across the head (anger, fear, surprise, sadness, joy, disgust)

Figure 64: 50 pixels across the head (anger, fear, surprise, sadness, joy, disgust)

5.6 Home lighting criteria

The tests in Section 4.2 are targeted at office scenarios. Home lighting is typically much lower than office lighting. Table 58 gives the test lighting targets for office and home environments. The light levels are measured on the test target. Devices targeting home Lync usage should use the home lighting levels instead of the office lighting levels for the tests in Section 4.2. Currently the home lighting levels are for guidance only and not part of the Lync requirements.

	Office lighting	**Home lighting**
Lower-level lighting	50 lux	20 lux
Ideal lighting	200 lux	80 lux

Table 58: Office and home lighting targets

6.0 Test report template

The Excel Workbook file "MLVideoCaptureSpecificationTemplateRevE.xlsx" is a test report template that includes calculations and criteria for many of the tests. Self-tests must complete this form for review by Microsoft. If the webcam uses OEM drivers then two workbooks must be submitted, one for Windows in-box drivers and one for the OEM drivers.